

DETAILED
SHELTER RESPONSE PROFILE

BANGLADESH

LOCAL BUILDING CULTURES
FOR SUSTAINABLE
AND RESILIENT HABITATS

1ST EDITION:
SEPTEMBER 2018



Cover images (from top to bottom):

Vernacular house in Bandarban;
Contemporary house inspired by vernacular architecture in Mymensingh;
Excavated pond and houses over earthen mounds in Asasoni.
Photos ©O. Moles



Transportation of the roof of a mosque in Sirajbag Island in the Jamura river (north of Dhaka), where floods are frequent. These types of buildings can be dismantled and rebuilt in a single day. ©National Geographic



House in Kuakata, in Barishal division. This house is built in a cyclone prone area with local materials and skills. ©O. Moles

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FOREWORD



VERNACULAR HOUSES IN BANGLADESH

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Barishal division



Chittagong division



Dhaka division



Khulna division



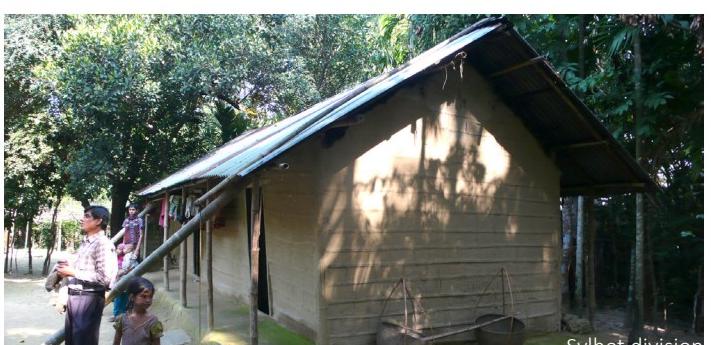
Mymensingh division



Rajshahi division



Rangpur division



Sylhet division



5TH COUNTRY MOST AT RISK: FLOODS, CYCLONES, EARTHQUAKES...

According to the 2016 World Risk Report, Bangladesh ranks as the 5th country most at risk of disaster with regard to both its exposure to natural hazards and the vulnerability of its people.

With 80% of its territory being river delta or alluvial plains less than 10m above sea level, almost each year around one third of the country is flooded during the rainy season. Every four to five years, more severe floods affect up to 60% of the territory. Approximately every 3 years the coastal zone of Bangladesh is hit by a severe tropical storm and tidal surge, leading to coastal erosion. River banks are also exposed to such erosions, both resulting in a growing number (approximately 10% in 2005) of land loss. Climate change will probably exacerbate these problems.

Another threat is that of earthquakes. It concerns about half of the country, including its capital, Dhaka and its population of 20 million that has a medium to high probability of being affected.



HIGH VULNERABILITY

Risks linked to natural disasters are aggravated by high levels of poverty (31.5% of the population below the poverty line) and high population densities, especially in the coastal zones which are the most prone to risks.

Over two thirds of the national labour force directly depends on natural resources with 50% directly employed in the agricultural sector and very much dependent on weather and climate conditions, making recovery even more difficult in crisis situations.

With such conditions, Bangladesh is regularly in need of medium to large scale international interventions. In addition, since 2017 Bangladesh has become the host country to around 900,000 refugees from Myanmar who benefit from emergency shelter in areas at risk, creating an unprecedented humanitarian challenge.



ADAPTED LOCAL BUILDING CULTURES

While impacts may evolve, the risk situation is not new in Bangladesh. For very long, local populations have been able to live there and to do so, they have found clever solutions to adapt to these hazards by solely using locally available resources. One of the reasons behind the increasing vulnerability of housing structures is that traditional solutions and their associated know-how and knowledge are let go of in favour of international building standards.

The average "core family" in Bangladesh is composed of 4.5 persons and typically male-headed, and it is very common to live within a larger extended family in shared homesteads.

In rural Bangladesh, around 75% of households live in *kutcha* houses, mostly self-built, usually constructed on an earthen plinth and using natural materials such as earth, bamboo and wood, with today a growing use of iron sheets (CGI) for the roofs. The poorest (often the landless) live in *jhuprie* huts, built with branches, bags, tarpaulin, etc. There is a trend towards *pucca* and *semi-pucca* houses, built with burnt bricks or cement blocks and an increasing proportion of reinforced concrete elements and thus considered more durable. In general, skilled labour for construction as well as the skills needed to plan, manage and supervise the implementation of quality construction are not easily available.

In urban areas, about 82% of residents dwell in sub-standard mostly rented housing, often in informal or illegal situations.



USE OF THIS SHELTER RESPONSE PROFILE

This Shelter response profile aims to provide a basic understanding of the context and the key issues relevant for shelter related operations, especially to support humanitarian projects through making the best use of existing good practices offered by Local Building Cultures (LBC).

In response to the climate, hazards and cultural needs, different local building cultures have been developed and can offer a whole variety of context-specific solutions, including with regard to local coping mechanisms. The information on LBC presented in this document is organised per division where solutions differ, and issues which apply throughout the country have been grouped in a single chapter.

The focus is on the local building practices and materials that support building back better and leverage people's capacities for self-recovery. At the same time dangerous or inefficient practices are highlighted and recommendations given for sustainable and resilient shelter practices.

In order to concretely illustrate the idea of drawing inspiration from LBC in a successful housing project, a number of examples of housing projects/architectural designs are presented in chapter 6, including basic information on unit costs and on the building techniques used. Pictures illustrate this chapter with houses inspired from traditional models that have been subjected to a reverse engineering process to adapt to contemporary constraints and possibilities and suit the evolution of lifestyles.

With this information at hand from the early stages of response, agencies can make informed choices for their shelter programming. Still, it is necessary to complete this information with dedicated field missions undertaken with local actors in order to verify local specificities in terms of land use/ownership, resources, practices, knowledge and capacities to implement construction works of different natures (p. 54-55).

1. INTRODUCTION

1.1. WHY LOCAL BUILDING CULTURES ARE IMPORTANT TODAY

All over the world, societies have managed to produce, adapt and develop their habitat according to their needs, interests, aspirations, preferences and abilities, making the best use of locally available materials. Strategies developed take advantage of natural resources to protect against the destructive forces of nature and have always generated rich and varied knowledge at local levels.

(Re)discovering the intelligence of local architectures and analysing their associated practices is often very useful in the process of designing disaster resistant architectures in accordance with build back safer principles, but also to adapt to contemporary lifestyles and their evolution, to respect the local environment and culture and to conform to the technical and economic capacities of local populations.

Relying on, or at least getting inspiration from local knowledge, know-how, construction processes and traditional means of organisation has proved very effective, as it favours:

- The implementation of solutions well adapted to local ways of life and the suggestion of viable improvements;
- The possibility to shelter many people quickly and cost-effectively while taking into account seasonality effects as well as factors like religious festivals and livelihood activities;
- Large-scale reproducibility of the improvements designed in continuity with local building cultures and an easy access, both financially and technically, to the promoted solutions for non-beneficiaries.
- A positive impact on local economies as local skills and materials are fully promoted, while also taking into account environmental concerns linked to the construction industry;
- Greater short and long-term ownership by the beneficiaries through their participation in decision-making and project implementation processes;
- Empowerment of local populations through the recognition of the value of their existing capacities and the improvement of their resilience.

To develop a disaster resistant architecture adapted to current local ways of life, it is important to involve the beneficiaries and the local professionals and decision makers from the very beginning of the recovery phase. If rebuilding is often necessary and can be very demonstrative and convincing, promoting pertinent repairs when possible may help reaching this goal. This way, the connexion between relief, recovery and development is enabled and so the long term benefit of a shelter project is ensured. In addition to the provision of shelters, higher levels of resilience within the project area are reached.

1.2. KEY CONCEPTS

BUILDING CULTURES

A building culture is the intangible dimension of a construction or a settlement produced by humans to live, work, thrive, etc., and is strongly connected with its environment. It includes assets related to each phase of the building life cycle: design, construction, use(s), maintenance, replacement, extension, adaptation, etc., which are often related to social, economic and environmental aspects as well as cultural aspects, including symbolic and representation systems.

The genesis and evolution of building cultures are closely linked to their environment and to the specific history of each territory. This is the reason why they are so diverse across the world and why several building cultures can co-exist within a single territory.

VERNACULAR HABITAT

Vernacular habitat is characterised by the use of local resources to respond to people's needs and to local climatic conditions. It is therefore closely linked to the site where it is built. It often results from reproductions, improvements and on-going adjustments or adaptations over time and may include external inputs and imported solutions, though rather parsimoniously. Such constructions, mainly handmade and outside or on the outskirts of global economic exchanges often rely on strong links between the inhabitants and their families and neighbours and their persistence may facilitate feelings of belonging and pride within the community.

PRECARIOUS HABITAT

The term "precarious habitat" covers different realities depending on the specificities of the places and the factors that generate it: economic difficulties, climate change, natural disasters or armed conflicts. It characterises houses or shelters built by low-income families or by those who, without a land property title, prefer to limit their investment by choosing light structures that are easy to dismantle or repair.

These constructions are primarily found within peripheral urban areas where illegality often correlates with a negative perception and with high risk, hazardous (disaster prone areas) and precarious living conditions that expose inhabitants to frequent destruction

of their homes. This inherently leads to constantly rebuilding, strengthening and fixing housing structures, which may reinforce people's knowledge on what works and what doesn't, but also drain their income.

Despite these challenges, their connection to cities and the opportunities they offer (educational, income, recreational, etc.) result in a strong attachment to these habitats. That leads to creative design solutions, including elements of comfort, income generating uses or external spaces of socialisation that do not exist in more formal habitats.

GLOBALISED HABITAT

Around the world, building is increasingly influenced by "global trends" and a growing interest in the reproduction of international solutions and in industrial materials such as cement, steel and CI Sheets. These are often implemented to replace more traditional materials (such as thatch) without considering that changing one element of the construction can affect the way the structure performs as a whole, possibly compromising structural safety, thermal comfort and other important features of the building. Therefore, one of the challenges of the LBC approach is to be able to take on board such tendencies and make sure that expectations are met when proposing designs for the reconstruction of shelter projects.

In post-disaster situations, some shelters are intended to be temporary structures made of short-lasting materials with designs that meet basic needs. But they often become permanent structures for families who lack the possibility to repair or improve them as their shape does not allow it or the materials and skills required are not available.

1.3. INFORMATION USED FOR THIS DOCUMENT AND HISTORY OF THE COLLECTION

A. INFORMATION AND DATA COLLECTION

This document was elaborated after a dedicated literature review (see chapter 7) and thanks to information collected during and after a number of previous experiences by the authors and their partners in Bangladesh, as well as through exchanges with Bangladeshi technicians and academics or Bangladesh-based experts.

B. HISTORY OF THE SERIES OF SHELTER RESPONSE PROFILES

This publication is part of the series of documents: "**Local Building Cultures for sustainable and resilient habitats**". Several documents have been produced, so far right after a disaster (Fiji, Ecuador, Haiti). This Shelter response profile for Bangladesh is the first attempt to have a document ready before a disaster strikes, allowing hopefully to follow a preventive approach when implementing housing projects and more widely within development projects involving a construction aspect.

Country/territory	Language	First edition	Available online
Fiji	English	March 2016 (after Cyclone Winston)	https://www.sheltercluster.org/fiji-cyclone-winston-2016/documents/fiji-baseline-data-local-building-culture-coping-strategies
Ecuador (Coastal area)	Spanish	May 2016 (after April 16 earthquake in Coastal area)	https://www.sheltercluster.org/sites/default/files/docs/ecuador_costa_habitat_local_y_estrategias_de_respuesta_craterre310516_1.pdf
Haiti	French	October 2016 (after Cyclone Matthew)	https://craterre.hypotheses.org/1803
Bangladesh	English	September 2018	https://craterre.hypotheses.org/2233

1.4. SUGGESTIONS FOR USE / AUDIENCE

The organisations backing this document have been working for several years on the elaboration and the dissemination of an identification method for local building cultures (LBC), especially in regard to their contribution to Disaster Risk Reduction (DRR). The aim is to facilitate the identification of the strengths and weaknesses of LBC and the opportunities they offer, in order to promote them – in an adapted version if necessary – in housing reconstruction or improvement projects.

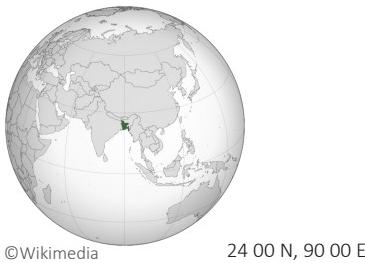
To achieve this, it is important to consider that beneficiaries live in environments that are often shifting due to several factors such as climate change, urbanisation processes, globalisation and the evolution of social attitudes as local practices are challenged. Still, it is advised that the solutions proposed are found locally and to keep innovations limited to improve their chances of being adopted and thus to contribute to long term development and increased local resilience capacity.

This document introduces reference data on local building cultures and local sociocultural resilient strategies. These references are to be considered as a basis for the elaboration of project-specific strategies and also as a grid of analysis with a first set of conclusions. Context and details will differ from one place to another and stakeholders will benefit from the collected data in order to make comprehensive and accurate decisions. It is highly recommended to complete them through the organisation of field surveys which will also allow to exchange with local actors on the specificities of each local context.

2. COUNTRY PROFILE

2.1. GENERAL DESCRIPTION

A. LOCATION



©Wikimedia

24 00 N, 90 00 E

Data from: CIA World Factbook, FAO, World Bank, Weatheronline, Climate portal, Wikimedia, Protected Planet

B. PHYSICAL AND TOPOGRAPHICAL DATA

Area: 148,460 sq km, including 90,990 sq km of agricultural areas and 14,310 of forests.

Elevation: average elevation: 85 m. Highest point: Keokradong, 1,230 m.

Relief: roughly 80% of the land is a mostly flat alluvial plain (Bangladesh Plain); hilly in the southeast. Most of the country is situated on deltas of large rivers flowing from the Himalayas: the Ganges unites with the Jamuna (main channel of the Brahmaputra) and later joins the Meghna to empty into the Bay of Bengal.

While altitudes up to 105 m above sea level occur in the northern part of the Bangladesh Plain, most elevations are less than 10 m above sea level; they decrease in the coastal south, where the terrain is generally at sea level. With such low elevations and numerous rivers, water and concomitant flooding are predominant physical features. About 10,000 sq km of the total area of Bangladesh are covered with water, and larger areas are routinely flooded during the monsoon season.

C. CLIMATE

Climate: Tropical. Mild winter (October to March). Hot, humid summer (March to June). Humid, warm rainy monsoon (June to October).

Rainfall per year: average 2,234 mm (1991-2015). With the exception of the relatively dry western region of Rajshahi, (1600 mm), most parts of the country receive at least 2000 mm of rainfall per year. Because of its location just south of the foothills of the Himalayas, regions in northeastern Bangladesh receive sometimes over 4000 mm per year.

D. PROTECTED AREAS

The [World Database of Protected Areas](#) cites 51 Protected areas in Bangladesh that can be viewed on this [map of Bangladesh](#). Protected areas are important biodiversity hotspots, as well as the source of livelihoods and natural resources used for housing for the local communities. These are mostly [national parks](#) (18) and [wildlife sanctuaries](#) (17). There are two [Ramsar sites](#) (wetlands of international importance): Sundarbans Reserved Forest in the Bay of Bengal and Tanguar Haor located in Sunamganj District (Sylhet division).

E. ADMINISTRATIVE DATA

Bangladesh is divided into **8 administrative divisions**: Barishal, Chittagong, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur and Sylhet. Divisions are subdivided into **64 districts** (*zila*), each further subdivided into **subdistricts** (*upazila or thana*).



Administrative divisions
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TO FIND OUT MORE

On sections 2.1. and 2.2.

CIA WORLD FACTBOOK

<https://www.cia.gov/library/publications/the-world-factbook/geos/bg.html>

FAO

<http://www.fao.org/countryprofiles/index/en/?iso3=BGD>

WORLD BANK

<http://www.worldbank.org/en/country/bangladesh>

WORLD DATABASE OF PROTECTED AREAS

<https://protectedplanet.net/country/BD>

UNHCR

<http://www.unhcr.org/rohingya-emergency.html>

2.2. DEMOGRAPHIC, CULTURAL AND SOCIOECONOMIC DATA

Data from: CIA World Factbook, FAO, World Bank, UNHCR, Nielsen report, UNICEF, ILO

A. DEMOGRAPHIC DATA

Total population: 157,826,578

Population density: 1,063 people/km²

Life expectancy: 73.4 years

Fertility rate: 2.17 births per woman

Infant mortality rate:

31.7 deaths/1,000 live births

Median age: 26.7 years

Age structure:

0-14 years: 27.76%

15-24 years: 19.36%

25-54 years: 39.73%

55-64 years: 6.93%

65 years and over: 6.23%

Net migration rate:

-3.1 migrant(s)/1,000 population

Urban population: 35.8%

Rural population: 64.2%

Urban population growth:

3.19% annual rate of change

Major urban areas:

Dhaka (capital) 17,598,000

Chittagong 4,539,000

Khulna 1,022,000

Rajshahi 844,000

B. LANGUAGES

Bangla or Bengali: 98.8% (official)

Other: 1.2%

C. ETHNIC GROUPS

Bengali: >98%.

Other ethnic groups: <2%. Bangladesh's government recognizes 27 ethnic groups under the 2010 Cultural Institution for Small Anthropological Groups Act. Other sources estimate there are about 75 ethnic groups.

D. RELIGION

Muslim 89.1%

Hindu 10%

Other 0.9% (Buddhist, Christian...)

E. EDUCATION

Literacy rate: 72.8% (age 15 and over)

Youth (15-24 years) literacy rate 2008-2012 - **Male:** 77.1% **Female:** 80.4%

Primary school participation, Net attendance ratio 2008-2012 - **Male:** 77.2%

Female: 81.2%

Secondary school participation, Net attendance ratio 2008-2012 - **Male:** 42.9%

Female: 47%

Intake capacity in Vocational Education and Training - building sector (2008 est.):

Building maintenance: 9,090

Carpentry: 630

Civil construction: 1,725

Plumbing and pipe fitting: 210

Intake capacity in engineering schools (2008 est.): 17,700

F. HEALTH

Physicians density:

0.47 physicians/1,000 population

Hospital bed density:

0.8 beds/1,000 population

HIV: 12,000 people living with HIV (<0.01%)

Major infectious diseases:

Food or waterborne diseases: bacterial and protozoal diarrhea, hepatitis A and E, and typhoid fever

Vectorborne diseases: dengue fever and malaria

Water contact disease: leptospirosis

Animal contact disease: rabies

G. ECONOMY (2017 est.)

GDP (purchasing power parity): \$686.5 billion

GDP - real growth rate: 7.1% (annual average GDP growth of about 6% over the last two decades)

GDP - per capita (PPP): \$4,200

GDP - composition, by sector of origin:

agriculture: 14.2%; industry: 29.2%; services: 56.5%

Labour force - by occupation (2016 est.):

agriculture: 47%; industry: 13%; services: 40%

Child labour: 4.7 million (12.6% of children aged 5 to 14 in the work force).

Population below poverty line: 31.5%

Inflation rate (consumer prices): 5.7%

Distribution of family income - Gini index:

32.1 (2010 est.)

Other information: Clothing exports accounted for more than 80% of total exports and surpassed \$28 billion in 2016-17. Improvements are needed in factory safety conditions and workers' rights to avert further high-profile accidents.

H. ACCESS TO INFORMATION

Telephones - fixed lines

Total subscriptions: 766,183

Subscriptions per 100 inhabitants: < 1

Telephones - mobile cellular

Total subscriptions: 135,981,846

Subscriptions per 100 inhabitants: 86

Radio and television access

Radio listening declined from 36% in 1999 to 15% of the population in 2011 and access to television in urban areas

increased from 69% to 91%, and from 24% to 67% in rural areas.

One in five Bangladeshis does not watch TV or listen to the radio at all.

Internet users

Total: 28,499,324

Percent of population: 18.2%

I. REFUGEES AND IDPs

Refugees: 905,000 (Myanmar) (2018). This figure includes an estimated 693,000 Rohingya (stateless Muslim minority) refugees who have fled conflict since 25 August 2017, when violence broke out in Rakhine State.

Over half of the new arrivals have sought shelter in and around the existing refugee camps of Kutupalong and Nayapara (Chittagong division) and in makeshift sites that existed before the influx. Some have joined relatives, others rely on social assistance.

New spontaneous settlements have sprouted overnight, raising concerns over the lack of adequate shelter, water and sanitation. Infrastructure and services are overstretched. Local villages have also taken in new arrivals, which has put a strain on their already limited resources.

These facts place pressure on the government's budget and the country's rice supplies, which declined in 2017 in part due to record flooding.

Internally displaced persons: 432,000 (conflict, development, human rights violations, religious persecution, natural disasters).

J. COMMUNICATION STYLE

Communication tends to be rather implicit/indirect. Long, rich and contextualized sentences which can often only be properly understood in relation to body language. It is important for people from explicit/direct cultures to understand that their communication style may be perceived as rude and the information provided inadequate. Rather than openly rejecting, replies can be phrased in such way that the answer can only be read between the lines. Phrases such as "we will try", "that may be difficult", or "we will have to give that some thought" may really mean "this cannot be done". Therefore, it is important to ask questions in several ways so as to be certain of what was meant. Silence is also often used as a communication tool.

Losing your temper or showing emotion may lead to a loss of credibility and respect. Meeting & Greeting etiquette in Bangladesh is reasonably formal. Proper behaviour is expected. Casual behaviour may be interpreted as impolite.

2. COUNTRY PROFILE

2.3. NATURAL HAZARDS, ENVIRONMENT AND CLIMATE CHANGE IMPACTS

A. NATURAL HAZARDS

Source: Asian Disaster Reduction Center, Reliefweb, IFRC, MUKUL et al (2014), MUNSHI KHALEDUR & SCHMIDLIN (2014), World Risk Report (UNU), Wikimedia, Preventionweb, Banglapedia

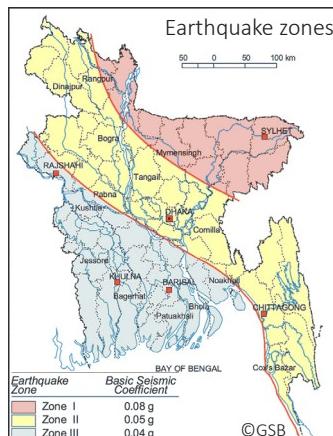
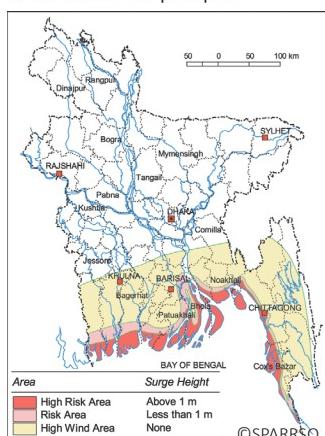
According to the 2016 World risk report Bangladesh ranks as the 5th country most at risk of disaster (after Vanuatu, Tonga, Philippines and Guatemala). This rating of countries "at risk" considers levels of exposure to natural hazards as well as different levels of vulnerability.

Around one third of the country is under floods during the annual rainy season. Every four to five years a severe flood affects over 60% of the country. Catastrophic floods have taken hundreds of lives and damaged crops, properties, and businesses worth billions of dollars.

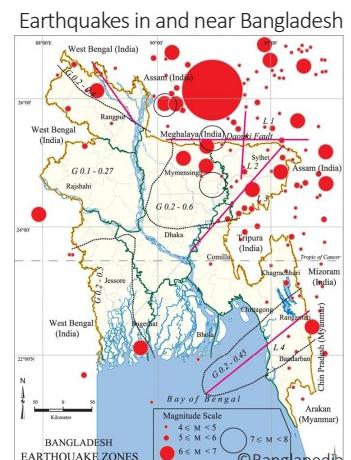
Approximately every 3 years, Bangladesh is hit by a severe tropical storm or cyclone. In recent years, cyclonic activity in the Bay of Bengal has become more frequent. It is estimated that 49 percent of the world's total deaths due to tropical cyclones occurred in Bangladesh. Between 1877 and 2009, Bangladesh was hit by 159 cyclones.

Earthquakes are less common but may cause severe damage, particularly in the north-eastern part of the country.

Coastal erosion accompanies regular tidal activities, but is conspicuous during monsoon seasons. Increased erosion and saline-water intrusion in coastal areas is likely to displace hundreds of thousands of people.



- CYCLONES & STRONG WINDS
- FLOODS
- EARTHQUAKES
- RIVERBANK / COASTAL EROSION
- TSUNAMIS & STORM SURGES
- SEA-LEVEL RISE
- DROUGHTS
- COLD WAVE



B. CLIMATE CHANGE AND ENVIRONMENTAL ISSUES

Climate change will exacerbate many of the natural hazards the country currently faces and the predicted higher wind speeds and storm surges will lead to more damage in the coastal region. Predictions include increasingly frequent and severe tropical cyclones, heavier/lighter and more erratic rainfall, higher river flows, river bank and coastal erosion, increased sedimentation, melting of the Himalayan glaciers and sea level rises.

In addition to climate change, two major environmental issues of concern are relevant to the shelter sector:

- **Deforestation:** One of the highest deforestation rates in South and South-East Asia, with an annual rate of 2%, and with a forest coverage as low as 10.2% (Mukul et al, 2014). This is mostly due to illegal forest activities and logging by poor communities living in the rural fringes adjacent to forests. There are laws that ban illegal logging, including the Forest Policy and the Forest Act but they are rarely enforced.
- **Riverbank erosion:** Riverbank erosion is a major issue in Bangladesh exacerbated in recent years by the over-extraction of sand from riverbeds for construction purposes (blocks, concrete, plasters...). Most rivers are now under threat from encroaching and illegal dredging. Sand has become a resource in high demand for concrete production along with the development of industrialisation in rural areas and land reclamation projects. The demand for concrete and cement-based products, which is predicted to increase sharply by 2050 with the changing living standards of an expanding population, will lead to further human and environmental risks.

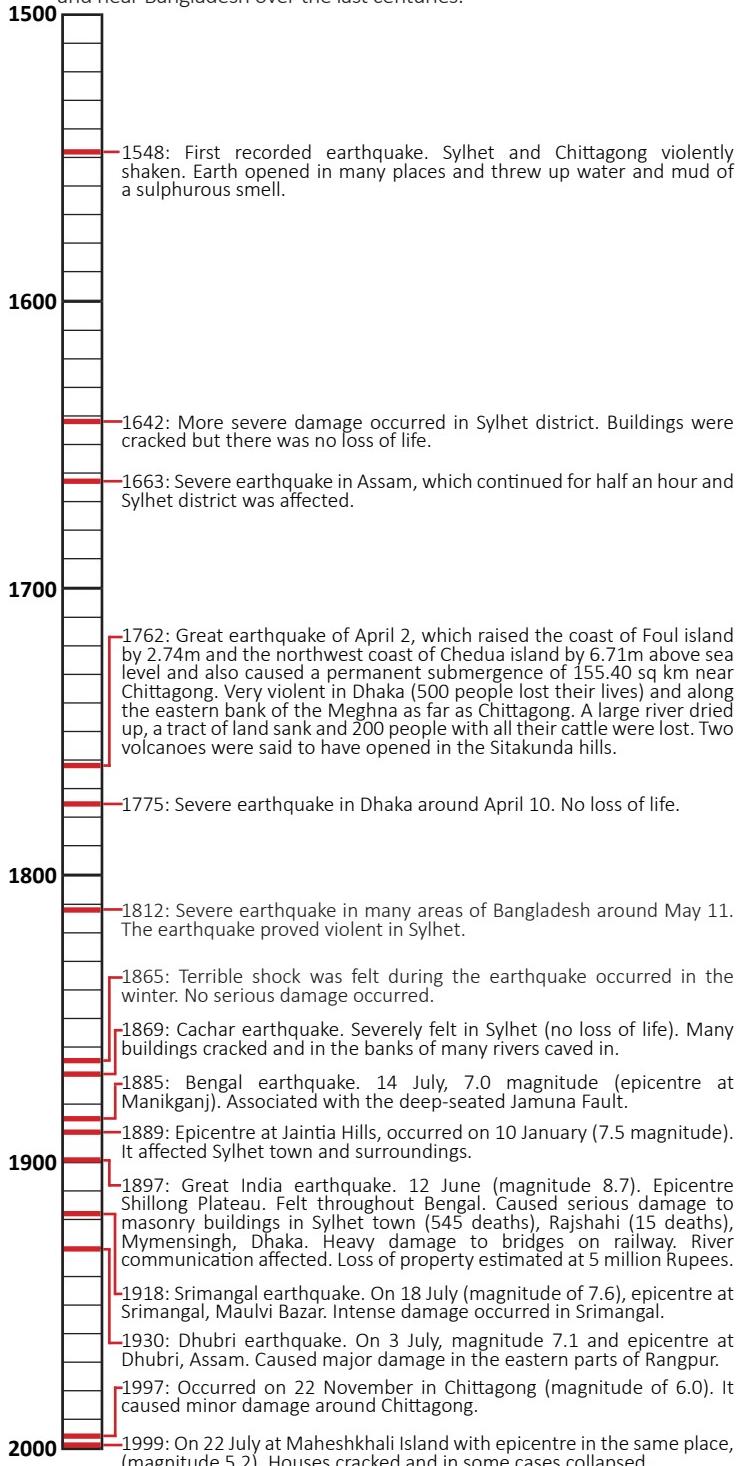
TO FIND OUT MORE

- GLOBAL RISK DATA PLATFORM
<http://preview.grid.unep.ch/>
- ASIAN DISASTER REDUCTION CENTER
<http://www.adrc.asia/>
- RELIEFWEB
<https://reliefweb.int/disasters?country=31#content>
- WORLD RISK REPORT 2016 (UNU)
https://collections.unu.edu/eserv/UNU:5763/WorldRiskReport2016_small_meta.pdf

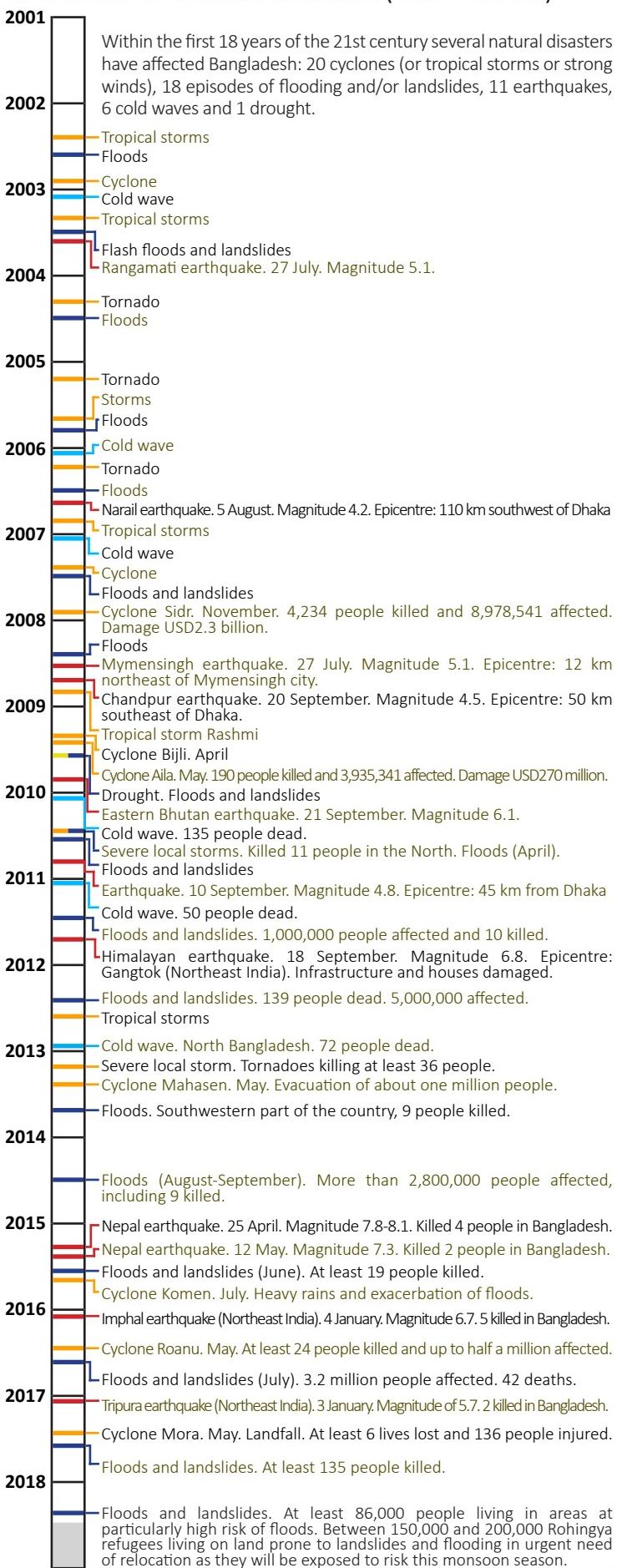


C. TIMELINE OF REGISTERED EARTHQUAKES (BEFORE 21ST CENTURY)

Unlike other natural disasters which are seasonal and recurrent in Bangladesh (e.g. cyclones, floods), it is not possible to have an accurate vision on the incidence of earthquakes in a territory within a small period of time. Consequently, this timetable shows the impact of earthquakes in and near Bangladesh over the last centuries.



D. TIMELINE OF NATURAL DISASTERS (21ST CENTURY)



LEGEND

- Cyclone, tropical storm or strong winds
- Flood and/or landslide
- Earthquake
- Cold wave
- Drought

3. ANALYSIS OF HOUSING

3.1. HOUSEHOLD COMPOSITION

Source: National Institute of Population Research and Training, CIA World Factbook and HAQ, S. U. (1992).

The variety of sociocultural contexts has led to a number of differences in the composition of households. As a result, only a field survey makes it possible to apprehend the realities in a given place.

That being said, general data is available for the entire country. In 2014, 87% of households are headed by men. Nonetheless, there is an increasing proportion of female-headed households, with no urban-rural difference. More than half of the households in Bangladesh are composed of two to four members. The overall average household size is 4.5 persons.

Traditionally in Bangladesh there are two scales in families: the joint family and the extended family. The joint family usually consists of two related married couples with their families. Usually they are father-son related or brother-brother related. Commensality (eating together) is proper to joint families, whose members usually contribute with a fixed amount to a common fund. The homestead built by the household head or an ancestor is the most important property owned by the entire family. An extended family is usually brought together by proximity or kinship. It is formed by one or more households living in adjacent dwellings. Most commonly, in rural Bangladesh, after the death of the family head, a joint family evolves into an extended family.

TO FIND OUT MORE*



*On section 3

- FAO
<http://www.fao.org/countryprofiles/index/en/?iso3=BGD>
- NATIONAL INSTITUTE OF POPULATION RESEARCH AND TRAINING
<https://dhsprogram.com/pubs/pdf/FR311/FR311.pdf>
- BARRIERS CONSTRAINING THE LOW AND MIDDLE INCOME HOUSING FINANCE MARKET IN BANGLADESH
<https://openknowledge.worldbank.org/handle/10986/26415>
- BANGLADESH HOUSING, LAND AND PROPERTY PROFILE (IFCR)
<https://www.sheltercluster.org/resources/documents/bangladesh-hlp-profile-ifrc-australian-red-cross>

3.2. INHABITANTS' ABILITY TO INVEST IN HOUSING

Source: FAO, UNDP, Bangladesh Bureau of Statistics, National Institute of Population Research and Training, CIA World Factbook, World Bank, KHARE, H. S. (2016)

A. GLOBAL OVERVIEW OF HOUSEHOLDS ECONOMIC SITUATION

In 2016, 13.8% of the population (22.5 millions people) lived with less than 1.9 US dollars per day per capita. In the same year, 51.5% of the population (83.9 million people) lived with 3.2 US dollars or less per day per capita.

In 2015, with a Human Development Index (HDI) of 0.579, the country ranked 139th out of 188 countries measured. This HDI has grown from 0.468 in 2000 (Low human development) to the present 0.579 (Medium human development).

In 2016, the Gini coefficient of Bangladesh was 0.32 (0 corresponding to total equality and 1 to total inequality), which places it among the 40 most equal countries by income in the world.

Agriculture employs about 50% of the total labour force. It provides for over half of the income of rural households through farming or wage labour on farms. Rural women are actively involved in farming, forestry, fisheries and livestock production. They often contribute to the household income through wage labour. Less than 10% of rural people have enough land to provide for their livelihoods.

B. TYPES OF HOUSING IN BANGLADESH

In Bangladesh, housing is classified into four categories according to structure type and the materials used:

- Jhuprie*: shacks made from branches, bags, tarpaulin, jute, etc.
- Kutcha*: made of earth, bamboo, wood and corrugated iron sheets (CGI) or thatch as roofs.
- Semi-pucca*: walls are made partially of bricks, floors are made from cement, and roofs from corrugated iron sheets.
- Pucca*: walls made of bricks and roofs of concrete slabs.

The fourth category is usually out of reach for the majority of Bangladeshis, who live in one of the three first structure types.

Size of Land (Acre)	Total (%)	Pucca (%)	Semi-Pucca (%)	Katcha-Durable (%)	Katcha / Non-durable (%)	Jhuprie/Katcha-Temporary (%)
TOTAL	100	3.65	10.80	41.89	34.18	9.47
LANDLESS	4.59	0.11	0.38	1.28	1.91	0.90
0.01-0.49	60.50	1.59	4.55	25.38	22.76	6.22
0.50-0.99	11.62	0.42	1.25	5.56	3.48	0.91
1.00-2.49	14.60	0.80	2.59	6.39	3.82	1.01
2.50-7.49	7.59	0.60	1.76	2.92	1.95	0.36
7.50+	1.11	0.13	0.29	0.36	0.26	0.07

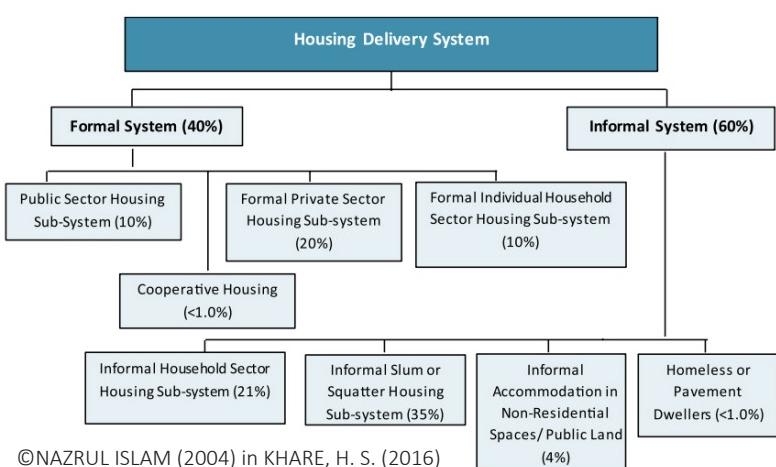
Percent of urban households by structure type ©KHARE, H. S. (2016)	Type of Structure	2001	2010
	Jhuprie	7.58	1.56
Kutcha	47.15	41.85	
Semi pucca	23.26	28.92	
Pucca	22.01	27.67	
Total	100	100	

Type of dwelling unit and size of land owned in rural areas, 2010.
©KHARE, H. S. (2016)

C. HOUSING SECTOR IN BANGLADESH

The residential housing sector of Bangladesh is characterised by a three-tier market:

- First are those households with the highest disposable income, able to afford high-quality housing in fully serviced neighbourhoods, and able to access bank financing or specialised housing finance institutions. This group represents less than 3% of the housing market.
- The second tier is the relatively narrow stratum of middle-income households that are the main users of specialised housing financial institutions such as the Banglsadesh House Building Finance Corporation (BHBFC). This group is the major beneficiary of available public subsidies and is composed predominantly of public servants and wage/salary earners of large private companies and the public sector; it represents 12-15% of the housing market.
- The third and largest tier is composed of low-income households, for which housing is provided largely by the private sector, or through self-construction often under illegal and unsatisfactory site conditions (uneven, flooded, landslide-prone sites, etc.). Access to and servicing of loans, regardless of debt servicing, is not possible. Urban development laws are largely ignored or disregarded for this large and growing market segment. It represents 82-85% of the housing market.



©NAZRUL ISLAM (2004) in KHARE, H. S. (2016)

Among the worst problems faced by urban populations is the acute housing shortage, which mainly affects those in the middle income and low income groups, forced to rent dwellings at costs very disproportionate to their income. Indeed, most of the income of underprivileged urban dwellers is spent on rent. Urban poverty is invariably associated with poor quality housing. Most poverty-stricken urban dwellers live in slums and squatter settlements characterised by substandard living conditions.

Underprivileged urban populations, often landless or with negligible land holding, struggle to afford residential land, generally expensive due to the high population density across the country.

D. NOTIONS OF COSTS FOR LOW-COST HOUSING (1USD = 79 BDT).

Type of construction	Low-cost brick and concrete pucca house built in self-construction by individual landowners - KHARE, H. S. (2016)-	Disaster resistant affordable house built using local materials and skills- SHARIFUL ISLAM, M., & REZA HOSSAIN, T., (2017)-
Cost per sq ft	BDT 1200-1500 per sq ft (\$ 15-19)	BDT 320-800 per sq ft (\$ 4-10)
Cost per house	BDT 600,000 (\$ 7,595) for a 400 sq ft typical low cost core house (structure only) comprising two rooms, kitchen, toilet and bath.	From BDT 65,000 (\$ 823) to BDT 160,000 (\$ 2,025) for a 200 sq ft house, depending on materials and zones.

Construction costs for disaster resistant affordable *kutcha* houses built using local materials and skills in the framework of a development programme carried out by Caritas Bangladesh, BUET and CRAterre (see chapter 6) are 2 to 4 times lower than those required for the construction of low-cost *pucca* houses.

E. AVAILABLE BUDGET FOR HOUSING AND AVAILABILITY OF LOANS

It is difficult to estimate the available household budget for housing. However, figures show that the average expenditure in housing is 10% of total consumption expenditure in Bangladesh, reaching 15% in urban areas.

According to those figures, an average family of 4.5 persons earning 1.9 USD per capita would spend 312 USD per year (10% of 3120 USD annual income) and in urban areas up to 468 USD per year on their accommodation or housing. For this family living in a situation of poverty by income, it would take more than 24 years to afford the above mentioned (3.2 D) *pucca* house and only between 2,6 to 6,5 years to afford a disaster resilient house built with local materials and skills (in a hypothetical situation where prices remain constant).

Households whose average monthly income is BDT 14,000 or less (177 US dollars per month, 2,124 US dollars per year) might be considered too destitute by mainstream primary lenders. However, the most affluent in this category could potentially qualify for housing loans offered by Microfinance institutions (Grameen Bank or Proshika) with interest rates between 6 and 8%, and with maximum amounts of 7,500 to 30,000 BDT.

Year	Residence	Avg. Total Exp. p.m.	Avg. Cons. Exp. p.m.	Housing / House Rent as % of Cons. Exp.	Housing Exp. Estimate
2016 ESTIMATE	National		16,505	10.00%	1,650
	Rural		14,154	8.00%	1,132
	Urban		22,914	15.00%	3,437
2010	National	11,200	11,003	9.95%	1,095
	Rural	9,612	9,436	7.29%	688
	Urban	15,531	15,276	14.41%	2,201

Average Total Monthly and Consumption Expenditure per Household in BDT (1USD = 79 BDT). ©KHARE, H. S. (2016)

3. ANALYSIS OF HOUSING

3.3. TENURE SECURITY ISSUES

Source: FAO, Bangladesh Bureau of Statistics, USAID, KHARE, H. S. (2016), OECD, IFCR, Australian Red Cross, Allens Lawyers

A. LEGISLATION AND ADMINISTRATION

The key pieces of legislation governing housing, land, building and planning include:

- The Transfer of Property Act 1882 which governs the transfer of private interests in land;
- The Registration Act 1908 which governs the registration of private interests in land;
- The Land Reforms Ordinance of 1984 which establishes a land ceiling, governs the distribution of Government land (*khas*) to the landless and regulates sharecropping agreements;
- The *Khas* Land Settlement Policy which also regulates the distribution of Government (*khas*) land to the landless.

The main government department responsible for land administration is the Ministry of Lands, which has the following divisions:

- The Directorate of Land Record & Survey, responsible for conducting surveys of land and producing individual land record certificates (*khatian*) and maps (*mouza*) for each plot of land;
- The Land Reform Board, responsible for administering Government land (ie, *khas*), setting and collecting the Land Development Tax, implementing land reform legislation, and preparing updated land record certificates (*khatians*) and maps (*mouza*) in between surveys. The Land Reform Board operates through upazila Land Offices and Union Council tehsil offices;
- The Land Appeal Board, responsible for determining appeals against the decisions of government officials in relation to land issues, namely land taxes, and the ownership and boundaries of land as recorded in land record certificates (*khatians*) and maps (*mouza*).

B. TENURE TYPES AND LANDLESSNESS

The three most common private tenure types in Bangladesh are:

- Common law freehold (ownership of land for an indefinite period);
- 99 years use rights to government land (*khas*) distributed to landless families;
- Leaseholds (the right to use land owned by another for a fixed period). Leases for agricultural land include both cash and sharecropping arrangements.

Less common types of formal tenure include: sharecropping agreement, customary ownership, co-operative ownership, tied tenancy, bed or room rental.

Informal tenure types include: leasing without a registered lease, and owning land which has not been correctly registered.

Finally, two types of squatting are also common throughout the country: squatting on land and living in self-constructed housing or shelter; or squatting on land by renting housing unlawfully constructed on the land by another person.

In 2005, 10.7% of households were landless. Many rural households have become landless after cyclones, floods and river erosion that render lands unsuitable for cultivation or shelter, forcing them to migrate to urban areas or settle on other marginal and disaster-prone lands.

Approximately 80% of the farms are classified as small (between 0.02 and 1.0 Ha, with an average farm size of 0.35 Ha) and they account for about 40% of the agricultural land area. Inequitable access to land is a fact, as only 1% of landowners own more than 3 Ha.

In 1996, 66% of houses were owned and 10% were rented. In 2005, in urban areas, 73.8% of slum shelters were rented.

TO FIND OUT MORE

- BANGLADESH HOUSING, LAND AND PROPERTY PROFILE (2018) (IFCR, AUSTRALIAN RED CROSS, ALLENS LAWYERS)
<https://www.sheltercluster.org/resources/documents/bangladesh-hlp-profile-ifrc-australian-red-cross>

Slum Population	
Six City Corporations (2005): Dhaka, Chittagong, Khulna, Rajshahi, Sylhet, Barisal	
2005 Population six City Corporations	15,447,046
2005 Slum Population	5,438,165
2005 Slum Population as % of total pop	35.2%
Number of slum clusters	9,048
Number of slum households	1,043,329
Slum land ownership	
Slums on government land	9.2%
Slums on private land	88.6%
Slums on "other" land	2.2%
Slum population by ownership	
Population on government land	27.1%
Population on private land	66.7%
Population on "other" land	6.2%
Tenure	
Households claiming ownership	14.5%
Households paying rent	73.8%
Household living rent free	11.7%

Population, land ownership and tenure in Six City Corporations (2005) ©KHARE, H. S. (2016)

C. GENDER ISSUES

Tenure issues are intensified by gender disparities. In 2014, Bangladesh was ranked among the countries with very high levels of discrimination in the SIGI Index (Social Institutions and Gender Index) by the OECD (ranked 94 out of 118 countries studied). This index takes into account Discriminatory Family Code data, restricted physical integrity values, son bias, restricted resources and assets and restricted civil liberties for women. There is available data on women's access to land, credit, non-land property, and inheritance practices.

Traditionally, in marriage, men have the ultimate authority on household resources, children and the management of the wives' labour, while women depend on their husbands and other male relatives for access to land. The number of female-headed households is increasing as a consequence of male migration (the increasing landlessness forces men to leave rural areas and often the country in search of wage labour). Several non-governmental organisations (NGOs) provide credit to women without a husband by means of micro credits.

In 1996, only 3.5% of agricultural lands were owned by a woman. Fewer than 10% of women have their name included on any documentation on property rights. In rural areas, women access land almost exclusively through their relationships with male family members such as husbands, fathers, or brothers.

Rural women are often the primary labour force on household lands and are severely affected by land loss caused by frequent flooding and erosion. Subsistence and income-producing crops are regularly lost and women usually cannot receive compensation for losses because the land is rarely registered in their names.

D. PUBLIC MEASURES TO COUNTER LANDLESSNESS

Khas land is unoccupied land that is legally owned by the Government and managed by the Ministry of Lands. It is legally reserved for distribution to landless households (1987 Land Reforms Action Programme), but the programme faced many difficulties and has only partially been enforced. The estimated amount of total identified *khas* land in Bangladesh is 1.2 million hectares, although some claim that this number is underestimated. In 2001, official sources claimed that about 44 percent of 325,000 hectares of agricultural *khas* land had already been distributed among the landless families. However, some groups of landless households are excluded, such as the households headed by unmarried women or widows with only daughters or no children at all.

Government has extended housing support in various projects:

- Cluster village: to rehabilitate houseless populations, including those affected by cyclones in coastal areas;
- Ideal village: project in which land/housing titles were given to low-income men and women jointly;
- Shelter project: housing fund to NGOs to provide housing for the rural poor.
- Return to Village Project: to rehabilitate urban slum dwellers evicted by the government.

E. RELIGION, CASTE AND HOUSING

Source: CHOWDHURY (2009)

Muslims represent 89.1% of the population in Bangladesh. Among the non-Muslims, Hindus are the dominant group with a population of about 10 per cent. Buddhists and Christians constitute less than 1 per cent.

Statistically, the Hindu population makes up a minority and the *Dalits* (castes subjected to untouchability) represent the most marginalised and deprived sections of the country. Studies on contemporary rural society acknowledge the existence of divisions also among Muslim populations in rural Bangladesh, broadly divided into a sort of caste system: *Khandan* (high status), *Girhasta* (low status) and *Kamla* (labourers/lowest status), with major cases of discrimination and exclusion. The estimation of the number of *Dalits* in Bangladesh varies from 3.5 million to 5.5 million (with about 45 diverse forms).

Dalits in Bangladesh are largely identified with their traditional occupations: fishermen, sweepers, barbers, washer men, blacksmiths, goldsmiths, cobblers and oil-pressers. Those engaged in these occupations face various forms of discrimination. They dwell in unsanitary and polluted environments, either in public housing provided by the local municipalities or in privately arranged housing in the slums/squatters in and around the semiurban and rural areas throughout the country. They are usually located in the most inhospitable areas which nobody else would covet, very often at the periphery of villages as they are considered unclean.

99% of the *Dalits* live in 1-2 room houses. *Dalits* are pushed to live in small and densely populated houses without any civic amenities. Only 44% of Hindu *Dalits* have access to tube wells, 22% to government provided water and sanitation (WASA), 17% to water ponds and 14% to other water sources; whereas 51%, 13%, 12%, and 11% of Muslim *Dalits* have access to tube wells, WASA, pond and other water sources respectively. Use of sanitary toilets is limited to 58% of Hindu *Dalits* and 44% of Muslim *Dalits* while 37% and 40% of Hindu and Muslim *Dalits* respectively use non-sanitary toilets. Finally, most *Dalits*, both from Hindu and Muslim communities live in *kutcha* houses built with easily available materials.

3. ANALYSIS OF HOUSING

3.4. ORGANISATIONS INVOLVED IN SHELTER, HOUSING AND DISASTER PREPAREDNESS

NATIONAL AUTHORITIES

Ministry of Housing and Public Works. <http://www.mohpw.gov.bd/>

- Housing and Building Research Institute. <http://hbri.gov.bd/>

This institute has vast research experience in alternative construction techniques. It also plays an important role in the development of the Bangladesh national building code (BNBC). Recently with HBRI it developed the “Standard guideline for rural housing in disaster prone areas of Bangladesh”.

- Department of Architecture. <http://www.architecture.gov.bd/>

- National Housing Authority. <https://nha.gov.bd/>

- Public Works Department. <http://www.pwd.gov.bd/>

Construction and maintenance of public schools, government official buildings, hospitals, monuments, etc.

- Urban Development Directorate. <http://www.udd.gov.bd/>

Ministry of Disaster Management and Relief. <http://www.modmr.gov.bd/>

- Department of Disaster Management. <http://www.ddm.gov.bd/>

This department has an engineering wing which has constructed disaster resilience houses, cyclone shelters, flood shelters, road and culverts in disaster prone areas.

- Cyclone Preparedness Programme. <http://voldb.cpp.gov.bd/>

Ministry of Environment and Forests (MoEF). <http://www.moef.gov.bd/>

Ministry of Local Government, Rural Development & Cooperatives.

- Local Government Engineering Department. <http://www.lged.gov.bd/>

Implementation of local government buildings, roads, culverts, bridges, drainages, etc., in rural areas.

- Ministry of Water Resources. <http://mowr.gov.bd/>

- Water Development Board. <https://www.bwdb.gov.bd/>

Mainly focusing on the development and management of water resource projects and the management and mitigation of river bank erosion.

INTERNATIONAL INSTITUTIONS IN BANGLADESH

- Bangladesh Red Crescent Society. <http://www.bdracs.org/>
- Bangladesh Shelter Cluster. <https://www.sheltercluster.org/asiapacific/bangladesh>
- UN-Habitat. <https://unhabitat.org/bangladesh/>
- UNHCR. <http://www.unhcr.org/bangladesh.html>
- UNDP Bangladesh. <http://www.bd.undp.org/content/bangladesh/en/home.html>

MAIN AGENCIES AND NGOS WITH SHELTER ACTIONS

- Care Bangladesh. <http://www.carebangladesh.org/>
- Caritas Bangladesh. <https://caritasbd.org/>
- Habitat for Humanity Bangladesh. <http://www.habitatbangladesh.org/>
- Islamic Relief Bangladesh. <http://islamicrelief.org.bd/>
- Muslim Aid Bangladesh. <http://www.muslimaid.org.bd/>
- Terre des Hommes Bangladesh. <https://www.tdh.ch/en/our-interventions/bangladesh>

UNIVERSITIES & TRAINING CENTRES

- Bangladesh University of Engineering and Technology (BUET). www.buet.ac.bd/

3.5. PREPAREDNESS AND POST-DISASTER STRATEGIES

Reduction in vulnerability is made possible through the resilient adaptive behaviour of communities as highlighted throughout this document, but is also the result of national led strategies, tools and media (risk awareness, building codes, increased incomes, etc.), which should advantageously be developed towards encouraging and facilitating existing resilience capacities.

These public strategies are essential to reduce vulnerability sustainably. As a matter of fact, over the last five decades (1965-2015), Bangladesh has been able to collect and invest about \$ 10 billion in disaster risk management (MECHLER & BOUWER, 2015).

The following measures have already been taken and must be developed in parallel with resilient practices applied by communities and families, which must always be promoted:

- Preparation of disaster management plans;
- Construction of cyclone and flood shelters to be used by local populations during hazardous events;
- Construction of river embankments;
- Implementation of drainage systems;
- Accomplishment of erosion control measures;



River embankment.
© Progress Bangladesh

- Development of adapted early warning systems for prevention before any upcoming catastrophe, including relying on local radio stations (in local language) for forecasting;
- Provision of safe drinking water, food, and medicine to people during and after hazard;
- Availability of agricultural insurance;
- Development of medical facilities and of health education.

Concerning preparedness for and adaptation to climate change, Bangladesh has made several commitments in the past years. These include:

- The Bangladesh Climate Change Strategy and Action Plan (2009);
- The Bangladesh National Adaptation Programme of Action (2005; updated 2009);
- The Bangladesh Environment, Forestry and Climate Change Country Investment Plan (2017).

Moreover, the Government's National Strategy "Vision 2021" outlines a strategic plan to achieve the government's development vision, mission and goals in advance of the 50th anniversary of Bangladesh's independence. Under Vision 2021, the Seventh Five Year Plan (FY2016-FY2020) currently in effect, stresses that while national capacity and expertise to address environment, climate change, and disaster management concerns have increased, the challenge remains to effectively implement policies and integrate lessons learnt.



Cyclone shelter.
© Kibria

3.6. CONSTRUCTION SECTOR

Source: AHMED, K. I. (1991); HAQ, S. U. (1992); KHARE, H. S. (2016); NAZIMUDDIN, A. (1985); MACKS (1990); SALMA, A. (2010), Banglapedia, « Flood Adaptive Housing in Bangladesh » (1990);

A. REGULATIONS IN THE CONSTRUCTION SECTOR

The major document regulating the technical aspects of construction in Bangladesh is the Bangladesh National Building Code (BNBC) 2008. The BNBC has been developed to set minimum technical standards for all *pucca* (concrete, brick, industrialised materials) constructions in Bangladesh. In addition to the BNBC, other important acts and policies are (SALMA A., 2010):

- The Building Construction Act, 1952;
- The Town Improvement Act, 1953;
- Building Construction Rules, 2008;
- Land Development Rules for Private Housing, 2004.

All the buildings in the metropolitan cities of Dhaka and Chittagong should be approved by RAJUK (Rajdhani Unnayan Kartripakkha, the Capital Development Authority of the Government of Bangladesh) or by city corporations.

In general the approval of a building design requires the following documents:

- Application form (From No. 301);
- Deed;
- Duplicate Carbon Receipt;
- Power of attorney (if applicable);
- Mutation;
- Indemnity bond;
- Draft Publication Form;
- 9 copies of the plan (for buildings up to 10 stories);
- Special project clearance and structural design (for buildings of more than 10 stories).

3. ANALYSIS OF HOUSING

B. SEASONALITY EFFECT

It is necessary to enquire about local particularities regarding construction seasonalities. Even though construction seasons are usually from September to December and from February to July, it is not possible to generalise. The country features quite important differences of climate from one territory to another and differences in agricultural production that have their own cycles in connection with the rains.

Rain is frequent and often building construction has to be carried out in spite of rainy weather, moreover during the monsoon season from June to October.

However, wooden / bamboo / CGI constructions are quite feasible in the rainy season.

C. CONSTRUCTION PROCESS

According to KHARE (2016), 60% of housing in Bangladesh is informal. Self-build by individuals, households, and communities is very common both in rural and urban areas in low and middle income contexts (rural landless or smallholders and urban slum and squatter dwellers).

There might be the eventual help of hired skilled labour but within reasonable limits.

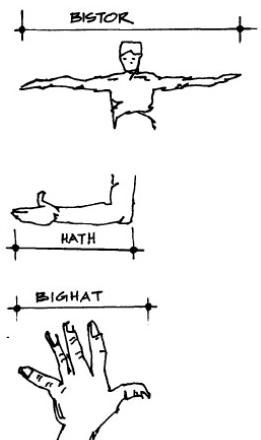
D. UNITS OF MEASUREMENT

In rural Bangladesh, units of measurements are linked to different parts of the human anatomy (*bastor*- wingspan, *hath*- ell, *bighat*- span). These units are also used in construction.

Traditional units are commonly used in construction and in land measurement. For instance, *katha* is a unit of area frequently used. *Bigha* is also a traditional unit of land valid across Bangladesh, with land purchases still being made in this unit.

Bangladeshi traditional area units	Equivalence in metric system	Equivalence in imperial units
Katha (area)	1 katha = 66,89 m ²	1 katha = 720 sq ft
Bigha (area) = 20 Katha	1 bigha = 1,337.8 m ²	1 bigha = 14,400 sq ft
Kani (area)	1 kani = 1,619 m ²	1 kani = 17,280 sq ft

To find out more on unit equivalences: <http://www.minland.gov.bd/site/page/4e44d7ef-2c36-4483-aa4e-77b294de729c/>



Human body based measurement units. ©Haq, S. U.

E. AVAILABILITY OF MATERIALS AND CONSTRUCTION SKILLS

MATERIALS

Local materials shaped the country's built heritage and still shape most rural houses. Since the country is essentially deltaic and riverine, a rich deposit of alluvium is available in many areas. Timber, bamboo, cane and reeds are also abundantly available throughout the country.

In recent years, hilly areas have suffered from severe deforestation. The supply of wood for building purposes is running short. Good quality timber is becoming scarce.

Bamboo is frequently used in construction. *Borak* is the type of bamboo most suitable for building structural elements. Other species are used for matting and wall cladding or to make furniture. Bamboo is vulnerable to attacks from insects such as borers and termites and to rot fungus, so treatment can be useful to improve durability more specifically when bamboo is to be exposed to damp conditions. Bamboo may be soaked in a body of water for weeks, soaked for months in mud or smoked on a fire. It can be treated with a natural Boron salt solution. Painting bamboo with bitumen is also a common practice. Fresh water is often used, which helps washing the bamboo of its sugars (that attract termites). In coastal areas seawater is used, which adds extra protection compared to a fresh water treatment (salt attacks termites by "pumping" their moisture as they have a very thin skin).

Earth is mostly used to build the plinths (*vita*) on which the houses are built (cob platforms) as well as walls directly on-site (cob walls). Production and use of sun-dried bricks are still carried out in less flood prone regions (as large drying areas are required for production). Different methods are used for the effective stabilisation of clayey soils. Lime and other traditional stabilisers (for example *surkhi*, that is obtained from broken pottery and fired bricks) are widely available and rather inexpensive. Other stabilisation methods such as the application of shale, chopped straw, cow's urine, cement, etc., are also practiced. There are certainly several recipes that may be localised depending on the availability of stabilising products. It is necessary to verify data in a contextualised way.

CGI sheets have been increasingly used as roofing and as wall elements since the late 1950s. They are usually imported (the corrugation may be done in Bangladesh), and too costly for most of the rural poor. However, investment in a CGI roof can still be interesting as the sheets can easily be sold in times of dire need (provided they are not deteriorated due to the way they are used or fixed). But lower quality sheets which are affordable to low-income groups corrode and develop rust quite rapidly. This deterioration increases thermal comfort and safety issues, and induces demoralising effects on their owners. These CGI sheets might also be dangerous during cyclones in coastal areas, as they can be detached by wind and cause injuries.

Concrete is used more and more in construction in Bangladesh. However, the use of concrete in structural elements is challenging in several ways (scarcity of good quality aggregates, lack of knowledge and skills to produce good concrete, salinity in coastal areas generating corrosion). Cement and steel are available in large and medium cities throughout the country.

Percent distribution of households by housing characteristics, according to residence, Bangladesh 2014

Housing characteristics	Residence		
	Urban	Rural	Total
Flooring material¹			
Earth, sand	32.5	81.5	67.8
Wood planks	0.4	0.2	0.2
Ceramic tiles	5.6	0.3	1.8
Cement	61.0	17.7	29.8
Roof materials			
Natural roof	0.2	1.7	1.3
Palm/bamboo	0.1	0.1	0.1
Wood plank/card board	0.1	0.0	0.0
Tin	70.0	90.8	85.0
Wood	0.2	0.2	0.2
Ceramic tiles	0.5	0.1	0.2
Cement	28.4	5.3	11.8
Roofing shingles	0.3	1.5	1.1
Other	0.1	0.3	0.2
Wall materials			
Jute stick/palm trunk	0.8	2.9	2.3
Mud/dirt	4.4	14.5	11.7
Bamboo with mud	4.5	8.9	7.7
Tin	30.2	48.3	43.3
Cement	52.6	15.9	26.2
Stone with lime/cement	1.6	0.5	0.8
Bricks	4.9	7.0	6.4
Wood planks	0.6	1.1	1.0

¹"Other" flooring material is a combination of palm, bamboo, parquet, polished wood, and carpet

Housing materials in 2014 (© NIPORT et al.)

Earth and sand continue to be the most used flooring materials, followed by cement.

Tin is the most common material in roofs with a huge difference with the second one (cement).

Tin, cement and earth are the most used materials for building walls.

This data may have altered due to the influx of refugees and of the associated demand for materials.

CITY	2008-09	2010-11	2012-13
DHAKA	191.01	233.49	344.66
BARISAL	238.79	280.48	380.05
CHITTAGONG	206.34	249.73	375.19
KHULNA	217.62	251.99	365.70
RAJSHAHI	220.89	259.61	358.53
SYLHET	209.68	244.18	351.64
BANGLADESH	214.06	253.25	362.62

Construction material price index. Base 1998-99=100.
© KHARE, H. S. (2016)

CONSTRUCTION SKILLS

Unskilled labour is prevalent in urban areas and a large percentage of workers are poor migrant women. Severe shortages exist in skilled manual, technical and managerial services in the housing construction industry.

There is a need for training of unskilled labour to improve the quality of housing and its production.

Carpentry work of good to excellent quality was noticed throughout the country (MACKS, 1990).

3. ANALYSIS OF HOUSING

F. COMMONLY USED MATERIALS: SOCIAL AND ENVIRONMENTAL IMPACT

MATERIAL	SOCIAL AND ENVIRONMENTAL IMPACT	SOCIAL & ENVIRONMENTAL BENEFITS	BETTER PRACTICES
TIMBER	<ul style="list-style-type: none"> Extraction can cause forest destruction, landslides, land degradation, and habitat destruction and can increase flood risk. Transport of logs can further damage forests and rural roads. Where processing takes place, poorly managed mills cause solid-waste pollution, noise and air pollution. Using toxic chemicals for treatment causes environmental and health hazards. Attempts to control illegal logging have been known to cause conflicts with local forest communities. In protected areas such as the Sal forests, gangs are reported to illegally fell trees for great profit, while influential locals also violate laws to collect firewood. 	<ul style="list-style-type: none"> A renewable resource, if well managed. Community forestry projects can reduce human/wildlife conflict and provide sustainable livelihoods to neighbouring communities. 	<ul style="list-style-type: none"> Do not overdesign/overspecify where possible, conduct proper structural design and calculate timber needs accordingly. Minimise cutoffs. Treat timber properly to ensure its long-term durability. Minimise the use of timber for formwork, prefer reusable modular formwork instead. Encourage timber reuse (e.g., door and window frames, roof members). Chemically treated timber cutoffs should be considered hazardous and never be used as firewood. There are certainly several recipes to treat timber that may vary locally depending on the availability of products.
BAMBOO	<ul style="list-style-type: none"> The importance of bamboo as a local resource makes it essential to consider the effects of large scale procurement on regional bamboo stocks and set systems to mitigate potential negative impacts. Bamboo is commonly a community resource and therefore the voice of the community is important at all stages of bamboo and bamboo products' procurement. Overharvesting means that greener bamboo is being used while it does not meet the standard of dryness required to extend its longevity (this is currently happening with the Rohingya crisis). Poor practices that often occur after a major disaster can devastate crop outputs for many years or in some cases permanently. Given its invasive nature, bamboo can quickly take over nearby forests. 	<ul style="list-style-type: none"> The high strength, low cost, rapid growth and high availability of bamboo makes this an ideal resource. Replenishes rapidly and over-extraction can usually be managed, with the exception of massive pressure put on local supplies as in Cox's Bazar with the Rohingya crisis. Good crop management practices can increase bamboo crop yields by up to 400%. Minimal impact on natural forests. Bamboo harvested during the monsoon season will be of better quality for construction (due to its dryness and resistance to insects). 	<ul style="list-style-type: none"> Encourage reuse (e.g., door and window frames, roof members). Never dispose of chemically treated bamboo in streams, wetlands, or coastal areas. Chemically treated cutoffs should be considered hazardous and never be used as firewood. There are certainly several recipes to treat bamboo that may vary locally depending on the availability of products.
THATCHING	<ul style="list-style-type: none"> Natural or farmed vegetation (e.g., palm leaves, reed, grasses) is used in thatching. Without proper management, negative impact on forests and natural vegetation may ensue. Household or small-scale industrial material; Material needs seasoning. 	<ul style="list-style-type: none"> No requirement for quarried materials or clay. No firewood or energy requirement. Can support indigenous livelihoods and valorise local knowledge. Does not harm the environment since it is biodegradable. 	<ul style="list-style-type: none"> Use local knowledge where possible. Use basic building designs. Support local livelihoods and industries. Consider fire risk in planning and design since thatch is combustible.
EARTH	<ul style="list-style-type: none"> Earth is a healthy material without toxic compounds (unless contaminated with toxic waste). Possibility of quarry problems (availability). In Bangladesh the extraction of earth can be done for the benefit of the development of environmental elements (canals, retention basins, plinths...). 	<ul style="list-style-type: none"> Earth has been used for thousands of years in Bangladesh (cob, adobe, plasters...). These building cultures result from knowledge, know-how and a collective intelligence improved over generations, through trials, failures and successes. Local material that does not require transportation. Earth does not create pollution and waste. Recyclable if it is not stabilised. Great variety of solutions, which allows for high levels of comfort if combined with knowledge on the bioclimatic conditions of each site. Effective regulator of humidity in indoor spaces, which increases comfort. Earthen construction encourages community self-reliance as it makes self-building possible. Earth reduces the economic dependence on the construction materials market, preventing indebtedness. Housing structures built with earth stimulate local activity by favouring production, processing and trade at the local level. 	<ul style="list-style-type: none"> Make use of local knowledge and local building cultures where possible. Extracted earth can benefit the creation of canals, retention basins, plinths, etc. Improve wall resistance with plinths built with stone, concrete or other inert materials. Avoid the implementation of massive earth walls in high flooding prone areas. Support local livelihoods and industries.

MATERIAL	SOCIAL AND ENVIRONMENTAL IMPACT	SOCIAL & ENVIRONMENTAL BENEFITS	BETTER PRACTICE
CONCRETE	<ul style="list-style-type: none"> Requires cement, quarried and mined materials (e.g., sand, rock chips and gravel). River sand or river gravel extraction contribute to river bank erosion and displacement. Often illegally extracted. For example, sediments in rivers are legal public property and cannot be extracted and sold by private companies though this is commonplace. Materials to make concrete such as river sand are often controlled by the “sand mafia” of influential local residents and the most vulnerable are subject to coercion and extortion. Extraction of sand erodes channel beds and river banks, increases channel slopes and leads to changes in channel morphology. This may cause: <ul style="list-style-type: none"> undercutting and collapse of river banks; loss of adjacent land and/or structures; upstream and downstream erosion; downstream changes in patterns of deposition; destruction of riverine habitats. Extraction of rock from quarries involves blasting. Quarries cause noise, dust, air pollution, habitat destruction and vibration if not properly managed. Unplanned rock quarrying can cause landslides and hydrogeological impacts. Without planning and protection blasting leads to occupational hazards. 	<ul style="list-style-type: none"> More resilient to cyclones and earthquakes if correctly designed and implemented. No firewood required. 	<ul style="list-style-type: none"> Use alternatives to concrete/ mortar, e.g., earth walls. Use premixed concrete instead of in-situ mixing. Use prefabricated concrete items. Never dispose of concrete in the environment. It can be: <ul style="list-style-type: none"> reused on-site/off-site for construction purposes (e.g., filling), safely transported to a construction material recycling facility, safely transported to a sanitary landfill.
BURNT BRICKS	<ul style="list-style-type: none"> Brick firing is an energy-intensive process. The brick industry is one of the largest consumers of coal and therefore also a significant air polluter. Air pollution and the use of good quality agricultural soil are the major environmental concerns related to the use of bricks. Brick kilns may emit toxic fumes (suspended particulate matter, carbon monoxides and oxides of sulphur) that are harmful to eyes, lungs, and throat. 	<ul style="list-style-type: none"> In some areas, the fired brick constructive culture may be alive and may be worth improving. Fired bricks and tiles have value and do not become waste (when used for stabilisation, shurki or even in concrete instead of gravel). 	<ul style="list-style-type: none"> Produce bricks on-site (e.g., stabilized earth blocks). Encourage the reuse of bricks from demolished buildings. Use standardised, quality controlled bricks for construction. Reduce waste by accurately estimating brick requirements. Use standard lengths and optimal wall thicknesses in design to minimise brick waste.
CGI SHEETS	<ul style="list-style-type: none"> Manufacturing process requires large quantities of steel, zinc and other metals. May contribute to negative mining impacts. Manufacturing takes place in large scale factories using energy intensive processes. Factories can cause severe air and water pollution, if poorly managed. Manufacturing processes may release toxic heavy metals. Transport can damage rural roads. Dangerous in cyclones. Cause discomfort and health issues. The main problem is the potential uplift of CGI sheets due to strong winds and improper fixations that may cause injuries and loss of lives. 	<ul style="list-style-type: none"> No environmental benefits. They are easy to carry and lightweight so no important structures are required to support them. CGI sheeting is valuable and can be sold if dwellers need to raise funds, for example in a disaster or post-disaster context. 	<ul style="list-style-type: none"> Use optimum design calculations to minimise cut wastes. Use certified products and avoid implementing in corrosive environments (e.g. seaside). Avoid contact with ground or high levels of moisture if using on wall panels. Encourage reuse of uncorroded sheets from old buildings.

G. FUTURE PREDICTIONS FOR PRESSURE ON BUILDING MATERIALS

An analysis of the 2001 Bangladesh Census indicates that households increasingly move to *pucca* houses as their income rises. The projected increase in per capita income by 2050 is expected to alter the mix of housing types with approximately 98% of households being able to afford a *pucca* house. Therefore it is predicted that the demand for bricks and concrete will increase dramatically. This may alleviate the deforestation issue, but will exacerbate the river bank erosion and sand mining impacts that are already displacing rural communities to city slums at rapid rates.

4. DESCRIPTION OF LOCAL HABITAT

4.1. LOCAL HABITAT: GENERAL DESCRIPTION

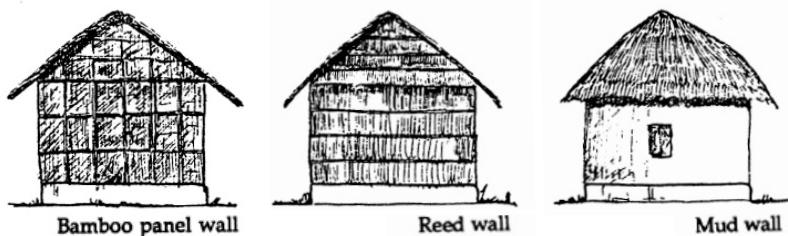
A. LOCAL AFFORDABLE OR SELF-BUILT HOUSING

83% of the population in Bangladesh lives in non-engineered housing structures, which can be classified into four categories according to type: *jhuprie*, *kutcha*, *semi-pucca* and *pucca*. These low-cost and/or owner-built houses can be categorised as vernacular (for *kutcha*), precarious (for *jhuprie* or eventually *semi-pucca* and *kutcha*) or resulting from global influences (for *pucca* and *semi-pucca*), according to the designs, materials and know-how used.

VERNACULAR HOUSING

Vernacular houses (*kutcha*) vary depending on their location. In the recent plains (75% of the country) the main vernacular building material is bamboo, in the pleistocene uplands the main material is earth and in the hilly regions the main material is traditionally wood but deforestation is nowadays slowing down the vitality of this building culture.

In these houses, walls can be of three types: bamboo panels, jute sticks or other local reeds; earth in layers (cob: stacked or hand-shaped earth) or in blocks; and corrugated iron sheets more recently. Roofs may also be made of three materials: jute sticks, thatch or corrugated iron sheets.



Different types of walls in vernacular houses (*kutcha*)
© Haq, S. U.

PRECARIOUS HOUSING

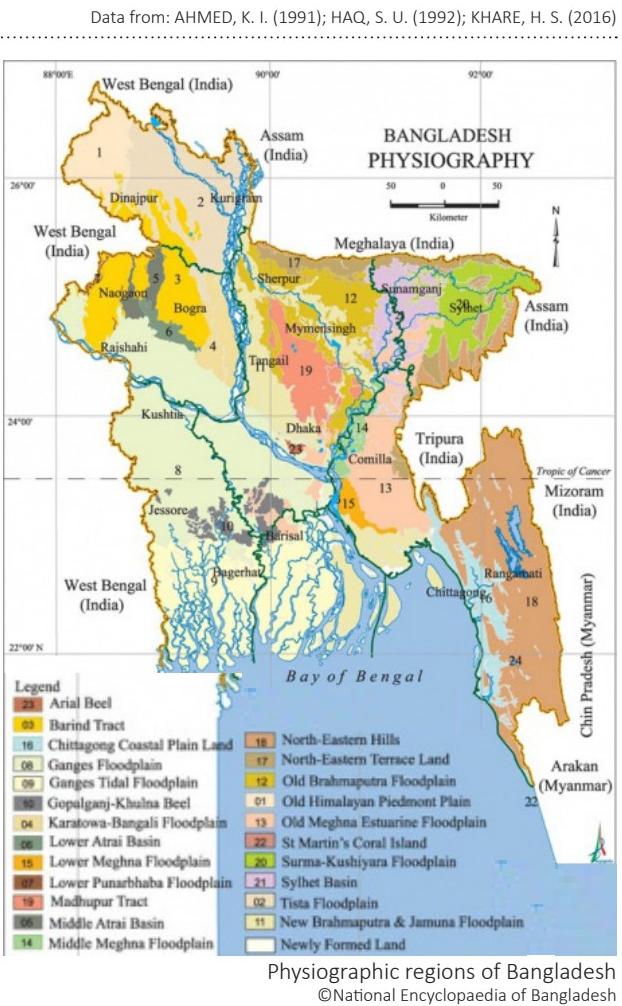
These structures are usually built with cheap or recovered materials. Shacks composed of branches, bags, tarpaulin, jute, etc. are locally known as *jhuprie*.

Precarious housing structures are usually found in slums in large cities. In areas affected by floods, they are built on stilts. Sometimes, *semi-pucca* and *kutcha* may also be considered precarious, depending on the construction materials used and on the quality of construction.

GLOBALISED HOUSING

Two kinds of housing structures resulting from global influences can be found in Bangladesh:

- *Semi-pucca*, with walls partially made of bricks, floors made of cement, and corrugated iron sheet roofs. These structures may also be quality constructions and thus not be considered as precarious.
- *Pucca*, with walls completely made of bricks and concrete roofs.



Precarious habitats on stilts in old Dhaka
© Uncornered Market



Pucca house in Barishal © lamudi.com

B. ACCESS TO WATER, SANITATION AND ELECTRICITY

Improved drinking water source:

Urban: 86.5% of population

Rural: 87% of population

Total: 86.9% of population

Improved sanitation facility access:

Urban: 57.7% of population

Rural: 62.1% of population

Total: 60.6% of population

Access to electricity:

73% of households (62% by the national network and 11% by solar power).

C. HABITAT ORGANISATION AND CONDITIONS OF USE

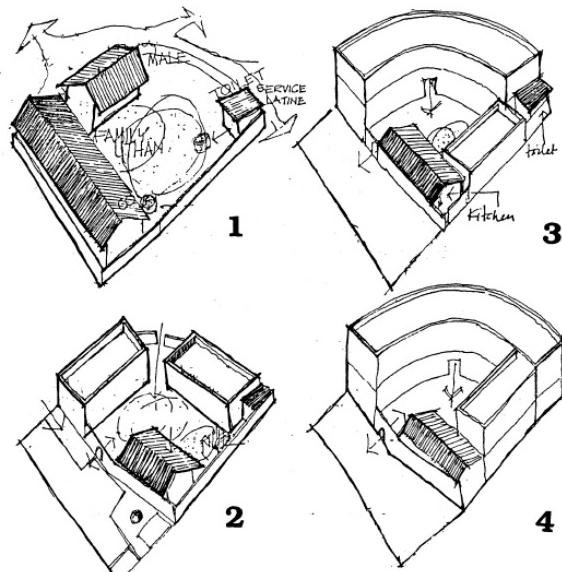
Housing structures were surveyed across all administrative divisions (Barishal, Chittagong, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur and Sylhet). A number of general characteristics are shared throughout the country both in urban and rural contexts.

No significant differences are noted concerning the number of rooms and of persons using them. Most houses feature two bedrooms (37.3%), followed by one-room houses (33.2%). One or two persons usually share each bedroom (65.3%), but it is also very common for a bedroom to be shared by 3-4 persons (27.2%).

URBAN HOUSING

Many urban dwellers make a distinction between the *bari* (rural house where the family is or was based) and the *basa* (urban house of residence). The *basa* is often considered as temporary, even when it is owned.

In urban settings, the first step in construction is the delimitation of the plot, usually through the implementation of perimeter walls. Originally, urban houses would conserve many of the characteristics of rural ones, such as the simplicity of spaces and construction, the occupation of the site with courtyards and their relationship to surrounding buildings, etc. Later, the lack of space in cities would lead to important transformations, more remarkably concerning the height and density of constructions.

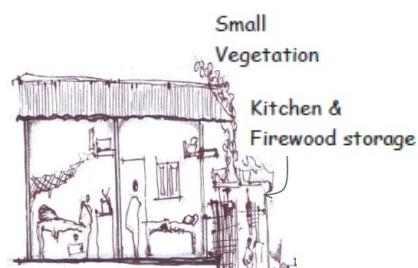


Chronological development of an urban house. © Haq, S. U.

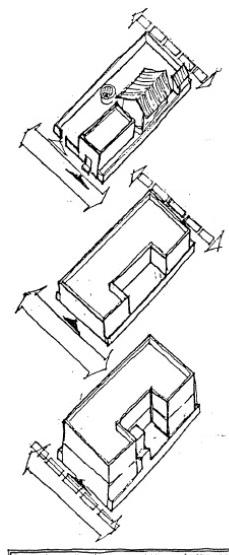
Percent distribution of households by housing characteristics, according to residence, Bangladesh 2014

Housing characteristics	Residence		
	Urban	Rural	Total
Rooms used for sleeping			
One	37.2	31.7	33.2
Two	36.2	37.7	37.3
Three or more	26.7	30.6	29.5
Total	100.0	100.0	100.0
Persons per sleeping room			
1-2	63.2	66.2	65.3
3-4	29.1	26.4	27.2
5-6	6.5	6.5	6.5
7+	1.2	0.8	1.0
Total	100.0	100.0	100.0
Number	4,844	12,456	17,300

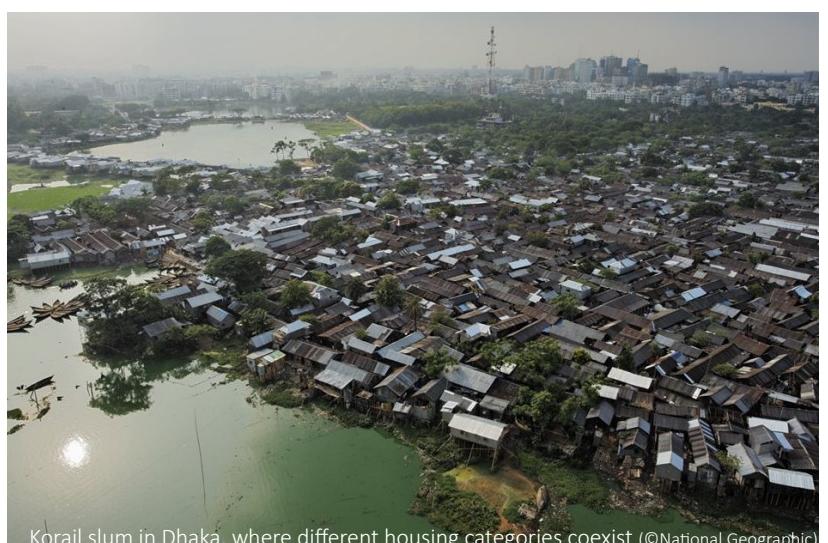
Housing characteristics in 2014. © NIPORT et al.



Owner-built temporary structures. © Anirban M.



Chronological development and plan of an urban house. © Haq, S. U.



Korail slum in Dhaka, where different housing categories coexist (©National Geographic)

4. DESCRIPTION OF LOCAL HABITAT

RURAL HOUSING

In the majority of rural Bangladesh, the first action undertaken to implement a dwelling is to raise a rammed earth mound (called *vita*, meaning plinth), which delimits the house and separates it from neighbouring areas. This mound becomes the spot where family life will take place, courtyards and huts will be created on it, but the whole mound will be considered the family's home. Building on plinths is a clever way to avoid the impact of average floods and to avoid being affected by the humidity of rice fields.

On top of the mounds, the Bengali house (*bari* in Bengali) is usually a cluster of constructions arranged around a courtyard (*uthan*). The courtyard is used for many different activities, it is a central element of the compound. Each construction has a particular function: bedroom, storage, kitchen, a place where male guests are entertained (*katchari*), cowshed, etc.

In each compound the main building will always have a courtyard in front of it. These courtyards are plain, have no plants and are very well maintained. Other constructions can then be built surrounding the courtyard in a four-sided layout.

As the family grows, the house evolves. New courtyards may appear on the same mound to respond to new needs. Three different courtyards coexist: the interior (*uthan*), the public and the service courtyard, which is linked to the kitchen. According to tradition, the interior courtyard is a private space, where women can perform all the family functions, while the public courtyard has a social function.

Most constructions are simple, rectangular and free-standing. Usually, the entrance door to the different rooms is placed at the centre of the long facade, which is the one directed to the courtyard. This connexion is very important. Verandahs are usually found between the constructions and the courtyard, particularly in front of the main building. Windows are usually small and few. Facades are often richly decorated and are limited by a plinth in the lower part and by extended eaves that protect the walls from rain.

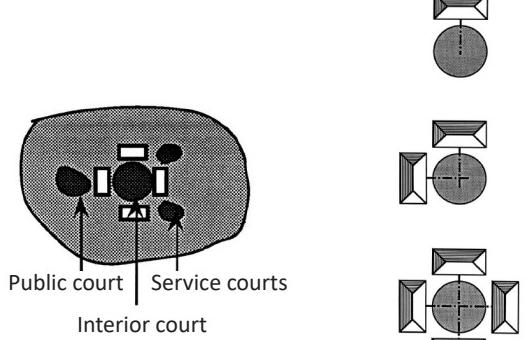
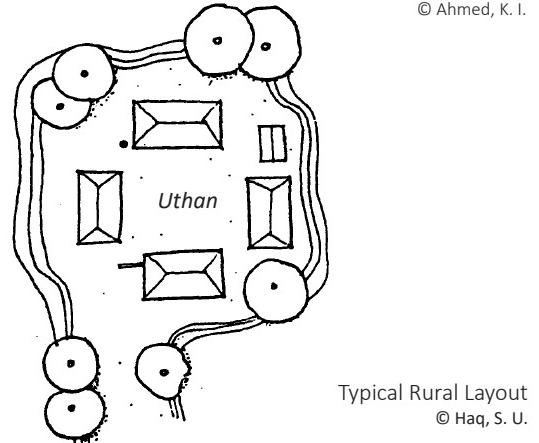
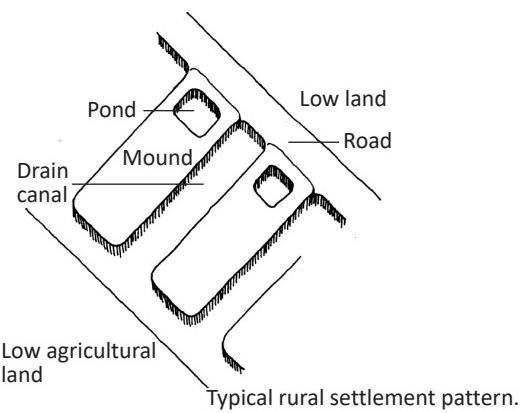
The different buildings usually shelter one single room, but it is also common to find partitions inside, internally distributed in a transversal manner.

In general, there are no covered spaces between the different constructions and so walking outside is required to move from one room to another even on rainy days.

Building dimensions vary from 12 to 24 feet long, 9 to 15 feet wide and their height is usually low. Floors are commonly raised from 1 foot to 1.5 feet from the homestead level, keeping the rooms drier than the courtyards.

The latrine is situated at a distance from these huts outside of the main courtyard within the same mound.

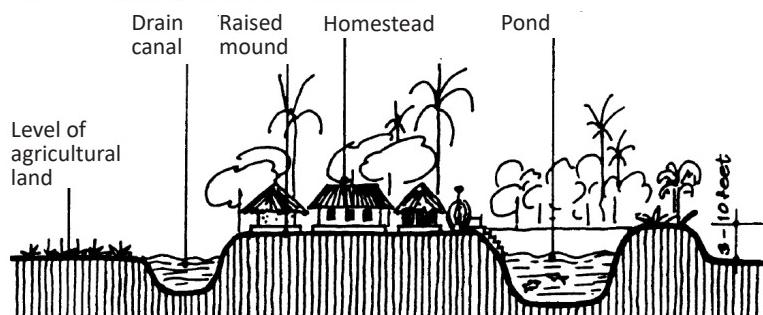
Vegetation is planted around the homestead to separate it from its environment.



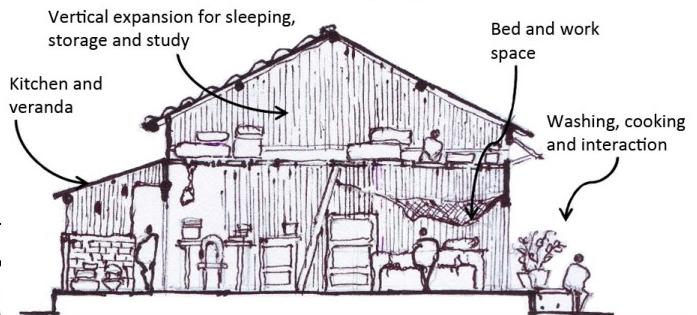
Different courtyards of a rural house. © Haq, S. U.

Formation of yards as central spaces when huts are built as needs evolve. © Haq, S. U.

Cross section of a rural house. © Ahmed, K. I.



Two-story house form with multiple use of indoor spaces in Gopalgonj (Dhaka division). © Anirban M.



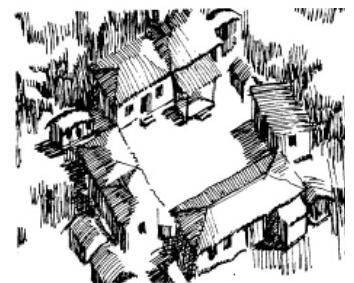
D. ARCHITECTURAL DESIGN PRINCIPLES: VASTU SHASTRA

Vastu Shashtra is the traditional Hindu system of architecture which literally translates to “the science of architecture”. This system found in the Indian subcontinent describes principles of design, layout, measurements, ground preparation, space arrangement and spatial geometry such as:

- The placement of the courtyard at the centre of the residence, open to the sky and without obstructions with an open gallery all around it. Rooms should be constructed around the courtyard (it is preferred that the entrance door faces the eastern direction);
- There should not be any common walls or columns in between two residences;
- Larger buildings must have thicker walls;
- The thickness of walls must be proportional to the width of the building [1/16];
- The height of the plinth must increase as the size of the buildings increases;
- Doors at the upper levels must be located exactly above the doors on the lower levels. The height of upper floors and consequently the doors must be lower than the height of lower floors;
- Verandahs must be implemented on all sides of the residence;
- *Chajja* (overhangs) must be projected equally on all sides of the building.

Even though the evolution of Islam has reduced its influence, some of these traditional practices are still applied.

Data from: AGRAWAL et al. (2016)



Example of housing unit in Bhangnahati,
Mymensingh Division
© Haq, S. U.



Constructions in Bandarban, Chittagong. ©O. Moles

4. DESCRIPTION OF LOCAL HABITAT

4.2. BARISHAL DIVISION

A. HAZARDS AFFECTING THE DIVISION

Cyclones and strong winds

Floods

Riverbank and coastal erosion

Tsunamis and storm surges

Sea-level rise

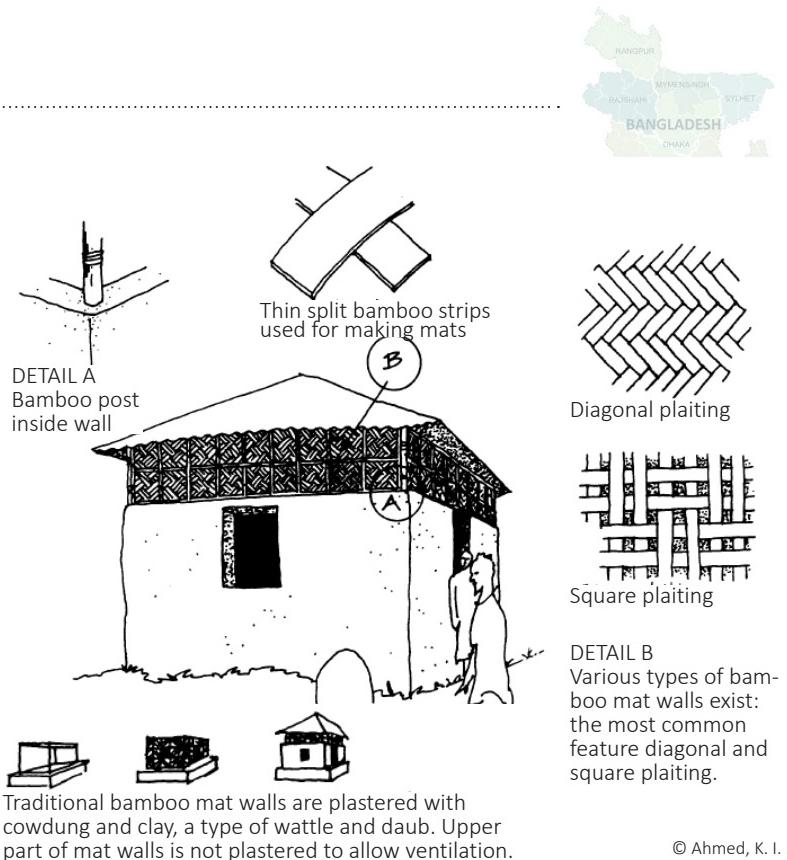
B. GENERAL DESCRIPTION OF HABITAT

In Barishal, stepped raised rammed earth plinths are frequent. Floors are usually made of earth (cob).

Walls are often built with lightweight materials and are subdivided into several panels by a non load-bearing timber frame. Today, the bearing structure (posts and beams) is commonly built in timber from locally available trees, but also in RC (reinforced concrete).

The roof may be of thatch or CGI sheets supported by a bamboo or wooden roof frame. Four pitched roofs are commonly implemented as they offer better resistance to high winds.

Two-storey buildings are not uncommon in Barishal.



DETAIL B
Various types of bamboo mat walls exist:
the most common feature diagonal and square plaiting.

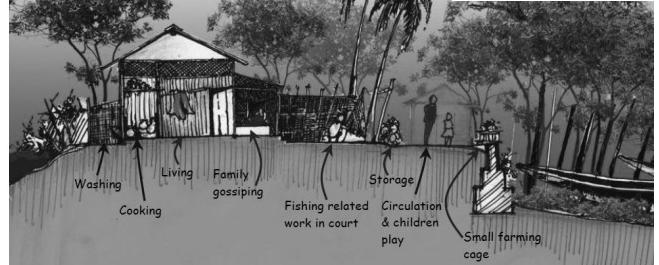
© Ahmed, K. I.



4.3. CHITTAGONG DIVISION

A. HAZARDS AFFECTING THE DIVISION

Cyclones and strong winds
 Floods
 Earthquakes
 Riverbank and coastal erosion
 Tsunamis and storm surges
 Sea-level rise
 Landslide and cold wave in hilly areas



Household activities in Jelepara, Chittagong. © Anirban M.

B. GENERAL DESCRIPTION OF HABITAT

Chittagong has two main geographical areas: the hills and the plains and coastal areas.

HILLS

In tertiary hills, buildings are raised on stilts (these houses are known as *machan* houses) to adapt to the uneven terrain. The rammed earth plinth is uncommon. The platforms raised on stilts serve as floors and are constructed out of wood or bamboo.

Walls are often built with lightweight materials and are subdivided into several panels by a non load-bearing timber frame. The lower portions of walls can be built with earth (cob), burnt bricks or cement blocks, and the upper parts with reed mats, bamboo mats or CGI sheets.

Timber is available but deforestation processes have already affected many areas. Concrete bases, locally known as *katla*, are used for improving the durability of timber posts. Bracings are sometimes included to enhance lateral load carrying capacity.

The prevalence of earthen buildings is less common in this area, the predominant building materials being bamboo, thatch and wood. Examples of earthen buildings constructed out of sun-dried bricks exist in some parts of the hilly regions, with good examples of two-storey buildings.

The roof may be made of thatch or CGI sheets supported by a bamboo or wooden frame.

PLAINS AND COASTAL AREAS

Very commonly a raised plinth of rammed earth is constructed, with a cob earthen floor.

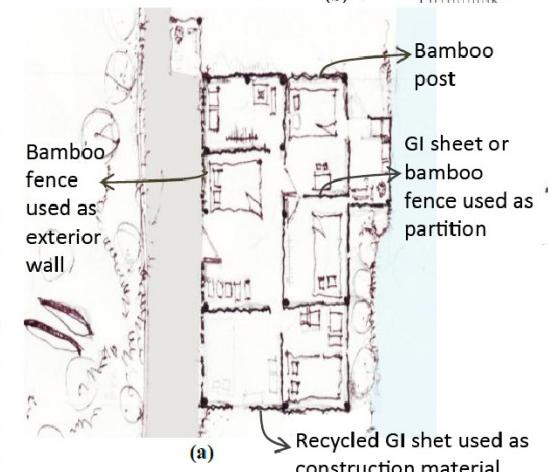
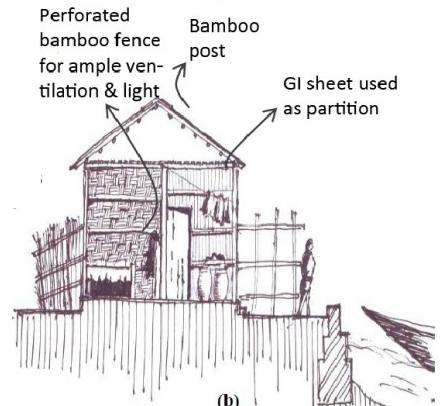
Walls are built with lightweight materials and subdivided into several panels by a non load-bearing timber frame. But in some of the plain areas, earth walls are also used.

Bamboo buildings are very present in coastal areas subject to high wind velocity and stormy weather. The tensile strength of bamboo frames is often suitable for resisting these environmental stresses. But this is not true in all cases. In areas with extreme wind conditions, bamboo frames are prone to great damage. Possibly for this reason, plastering is done to provide sturdiness to the structure.

The roof may be thatch or CGI sheets supported by a bamboo or wooden frame.



Bandarban (hilly zone), platform bracing. © Q. Moles



House in Jelepara Chittagong division. Plan (a) and section (b). © Anirban M.

4. DESCRIPTION OF LOCAL HABITAT

4.4. DHAKA DIVISION

A. HAZARDS AFFECTING THE DIVISION

Strong winds (tornadoes and nor'easter wind storms)

Floods

Earthquakes

Riverbank and coastal erosion

B. GENERAL DESCRIPTION OF HABITAT

In Dhaka division, houses are often built on a multi-step earthen plinth for better protection during floods.

Walls are often built with lightweight materials and are subdivided into several panels by a non load-bearing timber frame.

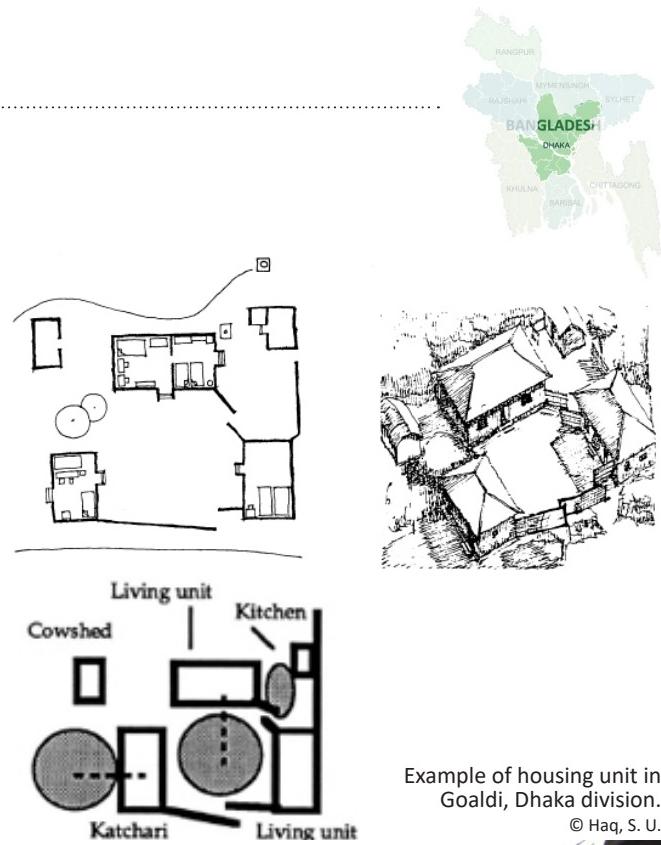
The bearing structure is built with timber from locally available trees or reinforced concrete.

In the northern portion of Dhaka, a building technique involving large earth blocks moulded and lifted into place is used at times. The vertical gaps between the blocks that result from the earth shrinking while drying are grouted with earth mortar. In most cases lime, and sometimes asphalt, is used on the exterior surface as finishing for protection against rain.

The roof may be thatch or CGI sheets supported by a bamboo or wooden roof frame.

Two-storey houses are not uncommon.

Carved wood and CGI sheet panels in Sirajdikhan. © O. Moles



Example of housing unit in Goaldi, Dhaka division.

© Haq, S. U.



Triple step plinth in Sirajdikhan. © O. Moles

4.5. KHULNA DIVISION

A. HAZARDS AFFECTING THE DIVISION

Cyclones and strong winds

Floods

Riverbank and coastal erosion

Tsunamis and storm surges

Sea-level rise

Droughts



House in Khulna. © O. Moles



House in Khulna. © O. Moles

B. GENERAL DESCRIPTION OF HABITAT

In Khulna division, houses are often built over a multi-step earthen plinth, with an earthen floor.

Walls are usually built with lightweight materials and subdivided into several panels by a non load-bearing timber frame.

Bamboo buildings are very present in the coastal areas subject to high wind velocity and stormy weather. The tensile strength of bamboo frames is generally suitable for resisting these environmental stresses. But this is not true in all cases. In areas with extreme wind conditions, bamboo frames are prone to great damage. Possibly for this reason, plastering is done to provide sturdiness to the structures.

Timber, RC and bamboo are used for the bearing structure.

Earth houses are also common (cob technique: stacked or hand-shaped earth). They are built mixing earth with water and straw, jute or rice-husk additives to provide strength during drying and shrinkage. The surfaces of earthen walls are plastered with earth mixed with cowdung.

The roof may be thatch or CGI sheets supported by a bamboo or wooden roof frame. Tiles are also common in the division. Thatch is less and less present.



Houses in Ashashuni, Khulna. © O. Moles



Tiles production. © O. Moles

4. DESCRIPTION OF LOCAL HABITAT

4.6. MYMENSINGH DIVISION

A. HAZARDS AFFECTING THE DIVISION

Strong winds (tornadoes and nor'easter wind storms)

Floods

Earthquakes

Riverbank and coastal erosion



B. GENERAL DESCRIPTION OF HABITAT

Houses are usually built around a courtyard on a multi-step earthen platform made with earth that is usually freely available right on the spot, with an earthen floor.

The lower parts of the walls are often built with earth (cob technique: stacked or hand-shaped earth), burnt bricks or cement blocks, and the upper parts with reed mats, bamboo mats or iron panels.

Compacted earth houses are common. They are built by mixing earth with water and straw or rice-husk additives to provide strength during drying and shrinkage. The surfaces of earthen walls are plastered with earth mixed with cowdung.

Light bamboo walls are also found, more commonly in flood prone areas.

A platform in the middle of the compound is often found and is used for storing goods and keep them away from potential floods.

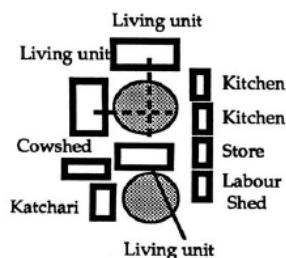
The roof may be thatch or CGI sheets supported by a bamboo or wooden roof frame.



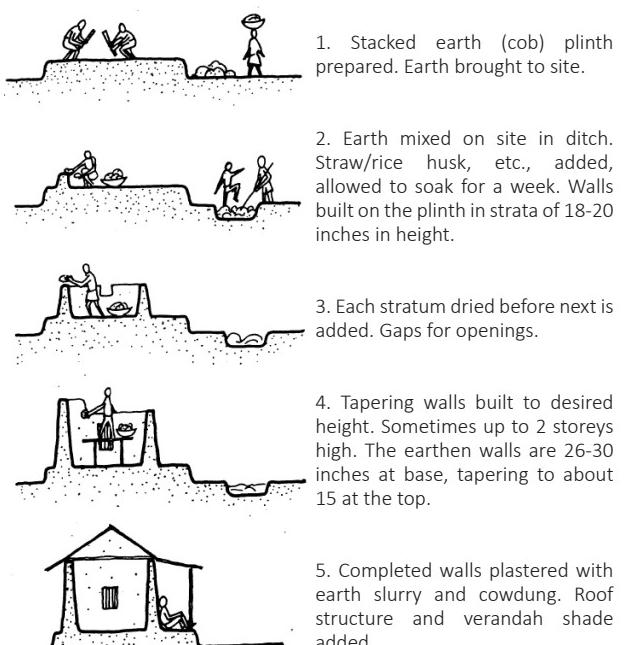
House in Mymensingh. © O. Moles



House in Mymensingh. © O. Moles



Example of housing unit in
Nayapara Maijta, Mymensin-
gh Division
© Haq, S. U.



Cob houses construction process.
© Ahmed, K. I.

4.7. RAJSHAHI DIVISION

A. HAZARDS AFFECTING THE DIVISION

- Droughts
- Floods
- Strong winds (nor'easter wind storms)
- Earthquakes
- Riverbank erosion

B. GENERAL DESCRIPTION OF HABITAT

Houses are usually built on a multi-step earthen platform made with earth, with an earthen floor.

In most of Rajshahi division, compacted earth houses are found. They are built by mixing earth with water and straw, jute, vetiver or rice-husk additives to provide strength during drying and shrinkage. The surfaces of earthen walls are plastered with earth mixed with cowdung.

Sufficient wall thickness is crucial to ensure durability and comfort. Fire bricks are also used.

The roof may be thatch or CGI sheets supported by a bamboo or wooden roof frame.

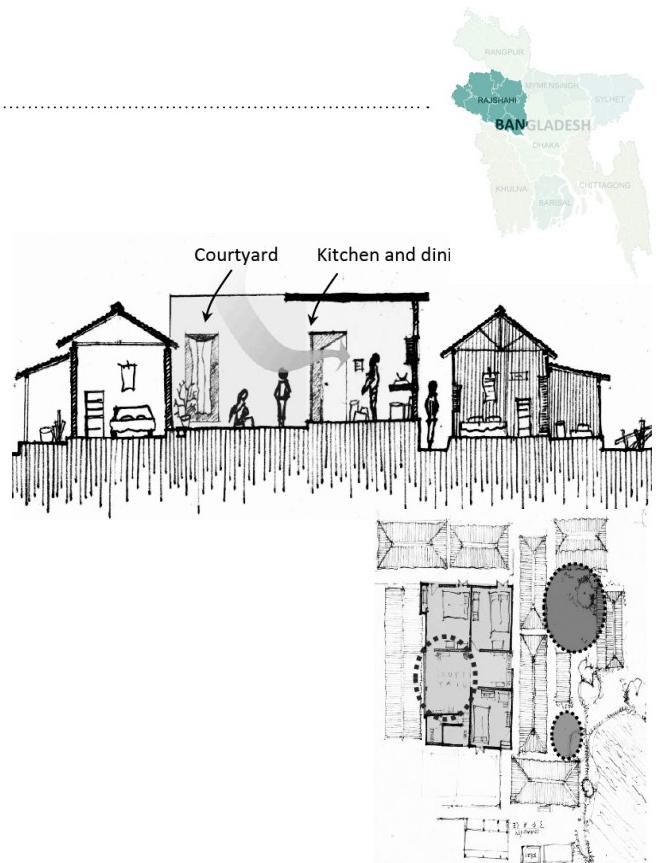
Two-storey buildings are not uncommon.

SIRAJGANJ DISTRICT

In Sirajganj district evolving houses can be found, from single rooms to multi-storey houses (over several decades, over several generations). Re-use of materials and the evolution of the structure are anticipated from the construction of the first unit.



Cob (compacted earth) houses in Rajshahi. © O. Moles



Owner built house with traditional courtyard en Sirajganj, Rajshashi division. © Anirban M.



Cob house in progress (left) and finished (right). © O. Moles



Courtyard between two-storey cob buildings in Rajshahi. © O. Moles

4. DESCRIPTION OF LOCAL HABITAT

4.8. RANGPUR DIVISION

A. HAZARDS AFFECTING THE DIVISION

Floods

Droughts

Strong winds (nor'easter wind storms)

Earthquakes

Riverbank erosion



B. GENERAL DESCRIPTION OF HABITAT

Houses are usually built on a multi-step earthen platform made with earth, with a bare earthen floor.

In Rangpur division, compacted earth houses are built by mixing earth with water and straw or rice-husk additives to provide strength during drying. The surfaces of the earthen walls are plastered with earth mixed with cowdung.

Sufficient wall thickness is crucial to ensure durability and comfort. Fire bricks are also used.

The use of CGI sheet panels is also common for walls.

The roof may be thatch or CGI sheets supported by a bamboo or wooden roof frame.

DINAJPUR DISTRICT

In Dinajpur district, shelter designs are different as it is a flood prone area. Houses must be displaced after the collapse of earth embankments where people live along river banks. The destroyed sites are drowned by the new river bed. People do not return to settle here, but rebuild on the new bank. This dynamic concerns hundreds of villages.

Consequently, demountable houses with demountable foundations are common. Posts with joints as well as connections between posts and roof systems allow for quick dismanteling and reconstruction.



Non-demountable house in Rangpur. © O. Moles



Demountable house in Dinajpur. © O. Moles



Interior view of a demountable house in Dinajpur. © O. Moles



View of a village besides a river in Rangpur. © O. Moles

4.9. SYLHET DIVISION

A. HAZARDS AFFECTING THE DIVISION

Floods

Earthquakes

Strong winds (nor'easter wind storms)

Riverbank erosion

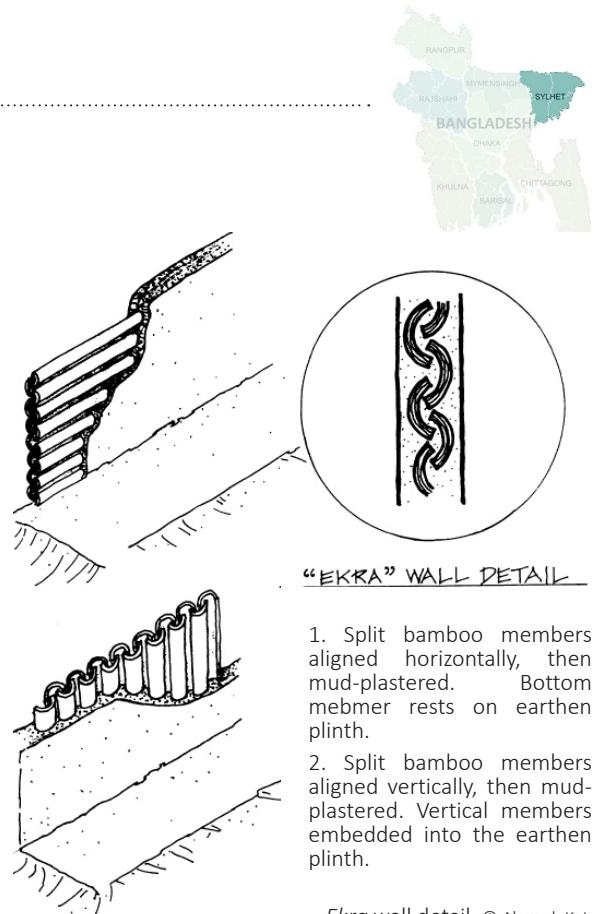
B. GENERAL DESCRIPTION OF HABITAT

In Sylhet, the lower parts of the walls are usually built with earth (cob), burnt bricks or cement blocks, and the upper parts with reed mats, bamboo mats or iron panels. Stone is available, but rarely used as a building material.

Earth (cob) houses are also found, they are built by mixing earth with water and straw or rice-husk additives to provide strength during drying and shrinkage. Earthen wall surfaces are plastered with earth mixed with cowdung.

Examples of well-developed wattle and daub systems can be found in some parts of the plains in Sylhet (also in Mymensingh), notably in the marshy lowlying area (Haor region). The system is locally known as *ekra*. The area experiences heavy rainfall annually, and hence the wattle and daub technique has been developed, allowing for the entire wall not to be washed away by the rain. After heavy rains, the wattle frame can be re-plastered and easily repaired.

The roof may be thatch or CGI sheets supported by a bamboo or wooden roof frame. Traditional burnt tiles made with rudimentary mechanised equipment are also found in the division.



1. Split bamboo members aligned horizontally, then mud-plastered. Bottom member rests on earthen plinth.
2. Split bamboo members aligned vertically, then mud-plastered. Vertical members embedded into the earthen plinth.

Ekra wall detail. © Ahmed, K. I.



Houses in Sylhet. © O. Moles



5. LEARNING FROM LOCAL HABITAT

5.1. HAZARD-RESISTANT PRACTICES

A. CYCLONES AND STRONG WINDS

[ALL BANGLADESH]

- Trees planted all around the house cut down wind speed, as do all other kinds of vegetation. However, high and rigid trees must be located far enough from the buildings to avoid danger in case of fall. It is therefore common to favour lower vegetation close to the house (bamboo, banana trees...) and to keep high trees at sufficient distance. Other advantages brought by vegetation are the regulation of temperature and humidity around the house as well as the provision of fruits, vegetables and livelihood for families.
- Horizontal timber battens at floor level and cross beams at roof level for bracing are commonly used.
- The roof is commonly used as a support for climbing plants and creepers. In case of strong winds, the risk of wrenching as well as of partial or total uplift is reduced as the plants fasten together the roof components and help stabilise the cover.
- The roof may be anchored to the ground through the use of ropes and wire fastened to wood stakes, used tyres or existing roots. The custom of not burying ferrous materials (use of tires, ropes) comes from the fact that the soil is salty, and therefore ferrous materials would rust too fast.
- Hip roofs (four pitched roofs) are commonly used because they are far less impacted by high winds.

[BARISHAL/ CHITTAGONG/ KHULNA]

- Buildings in the coastal areas are subject to high wind velocity and stormy weather. In the case of bamboo frame walls, their tensile strength is often suitable for resisting these environmental stresses. But this is not true in all cases. In areas with extreme exposure to wind, bamboo frames may be susceptible to great damage. Possibly for this reason, plastering is done to provide sturdiness to the structure.
- Height of houses is low in coastal areas for better resistance to winds.
- On pitched roofs, a diagonal timber element is sometimes placed between the rafter and the ring-beam on top of the walls, at both bottom corners of each roof panel. The goal is to brace the roof structure, improving its resistance to twisting during cyclones and strong winds.
- A protective device is often placed over the roof to prevent its damaging. For example: a fishing net, a bamboo grid or a fiber net (sometimes two of them) can be placed over a thatched roof, a tiled roof or an iron sheet covering and tied to the purlins or to another anchoring element.



Vegetation around a house in Kuakata (Barishal). © O. Moles



Climbing plants in Kuakata (Barishal) to protect roof from strong winds. © O. Moles



Roof anchored to roots in Khulna. © O. Moles



Fishing net for securing the roof in Khulna. © O. Moles



Combined fishing net and bamboo grid in Khulna. © O. Moles



Bamboo grid on CGI roof in Chittagong. © O. Moles

[BARISHAL/ CHITTAGONG/ DHAKA]

- Walls are often built with lightweight materials and are subdivided into several panels by a non load-bearing timber frame.
- The timber frame increases the stiffness of the walls made out of lightweight panels, reducing the risk of wrenching under strong wind pressure.

[KHULNA/ MYMENSINGH/ RAJSHAH/ RANGPUR/ SYLHET]

- In buildings with massive earthen walls, top plates are tied on both sides with ropes to horizontal bamboo pieces or bricks embedded through the walls. This prevents the roof from being blown off or distorted, especially when iron sheets are used as covering and is a minimalist but very effective solution, not requiring particular skills or important financial efforts to be implemented. It must be noted that the top of the wall must be protected with a harder material to avoid erosion due to the friction of the ropes.
- Bamboos are placed above the roof covering and fastened to the roof structure or to bamboos placed under the covering. For tiled roofs, bamboo slats are arranged above the first lower row of tiles and fastened to the roof structure with a rope passing through holes drilled in the tiles. This fastening prevents the uplift of the lower rows that are the most exposed to wind pressure.
- On both sides of a gable (2 slopes) iron sheet roof, bamboos are placed above the roof covering and tied to wooden or bamboo stakes driven into the ground, contributing to reduce wind effects, especially near the gables.



CGI sheet light wall panels in Sirajdikhan (Dhaka). © O. Moles



Tiled roof fastening against strong winds effects in Khulna division. © O. Moles



The roof is tied to bamboo pieces embedded through the walls (Mymensingh). © A. Caïmi



Wooden bracings and katla (concrete plots) in Barishal. Project by DFID and BRAC University. © O. Moles



Roof anchoring with fired bricks in Rajshahi. © O. Moles



Tyres anchoring in Rajshahi. © O. Moles



Sheet fastening with bamboo (Rangpur). © O. Moles

5. LEARNING FROM LOCAL HABITAT

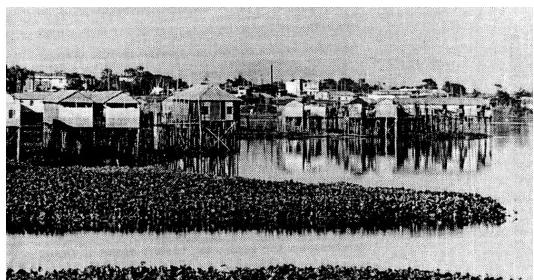
B. FLOODS

[ALL BANGLADESH]

- The home building process in the flood-prone Gangetic valley starts very often with the creation of a platform (*vita*). This is accomplished by raising up an earthen mound on the low lands above the average annual flood level. This is a fact for rural houses, that are often built on a multi-step earthen platform whose edges work as a sacrificial mass in case of floods. This solution is very effective and it can be done at minor cost with earth from the site. However, regular maintenance is required to ensure its effectiveness.
- In areas where earthen platforms are difficult to build, for example on the outskirts of cities, where such elaborate endeavor is either not possible or forbidden, houses are usually built on bamboo stilts.
- Vegetation cover around the houses protect them from floods effects.
- Inside the houses, indoor furniture and/or special platforms, closed in some cases, are raised above the ground level. They provide elevated spaces for keeping goods safe and for families to stay above the water level during floods and be protected from snakes. While furniture and raised platforms may take up a lot of space indoors, this is generally in line with the way dwellers occupy interior spaces, as they commonly use the platforms for sleeping and sitting.
- Elevated light platforms are built using bamboos and woven mats inside the house as attics or outside under the roof eaves, making it possible for goods, food and wood for cooking to keep safe from rising water during floods.



Houses built by NGOs on earthen plinths in paddy field after the cyclone Sidr in Kuakata zone (Barishal). © BUET



Old picture of houses on stilts in a peripheral area of Dhaka. © Haq, S. U.



Vegetation barrier as useful protection from floods and cyclones. © A. Caïmi



Elevated houses and mixed walls in Sirajdikhan (Dhaka). © O. Moles



In case of light roofs in flood-prone areas, empty jerrycans are sometimes fastened under the roof structure. During high floods, the roof is detached from the main structure (or loosely connected to it) and the jerrycans work as floats avoiding a complete sinking of the roof (not a very common practice). © O. Moles



Floating roof. © Unknown

[BARISHAL/ CHITTAGONG/ KHULNA]

- The roof structure is sometimes borne by an independent timber or bamboo frame while the interior space is fenced by non-load bearing earthen walls. The posts may be indoors or outdoors. In case of damage to the walls during floods or earthquakes, the frame can stand on its own, hence preserving the roof which is often the most expensive part of the construction. Moreover, the space under the supported roof can be used as an emergency shelter.
- In case of light roofs and in flood-prone areas, empty jerrycans are sometimes fastened under the roof structure. During high floods, the roof is detached from the main structure (or gets loosely connected to it) and the jerrycans work as floats avoiding a complete sinking of the roof. Damage to the roof is significantly reduced as the whole roof is kept above the water level.



Elevated furniture. © O. Moles



Elevated box platform. © A. Caïmi

[RAJSHAI/RANGPUR]

- In Sirajganj district (Rajshahi) and Dinajpur district (Rangpur), houses (wall panels, roof panels and joints) are designed to be quickly and easily dismantled, moved and reassembled by dwellers. During exceptionally high flooding episodes, dwellers dismantle their houses and temporarily move them to a safer place (embankment, inland). A fast recovery is then possible as the materials composing the house are preserved and can easily be reused.

[SYLHET]

- Planks are used as removable barriers to be placed on door sills during floods.



Demountable house in Sirajganj district. © sos-arsenic.net



Elevated box platform. © A. Caïmi



Movable barrier in Sylhet. © O. Moles



External mezzanine to save goods in flood prone area.
© O. Moles

5. LEARNING FROM LOCAL HABITAT

C. EARTHQUAKES

[ALL BANGLADESH]

- The lower parts of the walls are usually built with earth (cob), burnt bricks or cement blocks, and the upper parts with reed mats, bamboo mats or iron panels. This way, in case of floods and earthquakes, heavy materials are unlikely to harm someone.
- The roof structure is sometimes borne by an independent timber or bamboo frame while the interior space is fenced by non-load bearing earthen walls. The posts may be indoors or outdoors. In case of damage to the walls during floods or earthquakes, the frame can sustain itself independently, hence preserving the roof which is often the most expensive part of the construction. Moreover, the space under the supported roof can be used as an emergency shelter.

[[KHULNA/ MYMENSINGH/ RAJSHAHI/ RANGPUR/ SYLHET]

- In buildings with massive earthen walls (cob), bamboos are sometimes embedded into the walls during construction, between the layers. Bamboo culms or slices are placed horizontally on the entire length of the wall with a spacing of 10 to 60 cm. They act as reinforcing bars similarly to steel bars in reinforced concrete. Thanks to the high tensile strength of bamboo, the behaviour of the wall under horizontal seismic stresses is improved, counterbalancing the rather low tensile strength of massive earthen walls. The addition of bamboo also helps to prevent cracking in case of vertical deformation caused by differential settlement of the ground.

[RAJSHAHI]

- In Rajshahi, holes are left into the load-bearing masonry walls in order to let load bearing beams pass through without any locked joint. The holes are a bit bigger than the size of the beams. During earthquakes, the beams are free to move horizontally and independently from the walls without affecting the main masonry structure, which prevents cracks and failures due to punching.

[SYLHET]

- Short pieces of wood are sometimes diagonally placed at the corners of the structural frame. They work as bracing keeping the structure from bending under lateral loads due to earthquakes or strong winds. These short timber pieces are cheaper than the long ones and less problematic for placing doors and windows.



Heavy materials in lower part of the walls (Chittagong).
© O. Moles



Bamboos are sometimes embedded into cob walls.
They improve the behaviour of the wall under horizontal seismic stresses (Rajshahi). © sos-arsenic.net

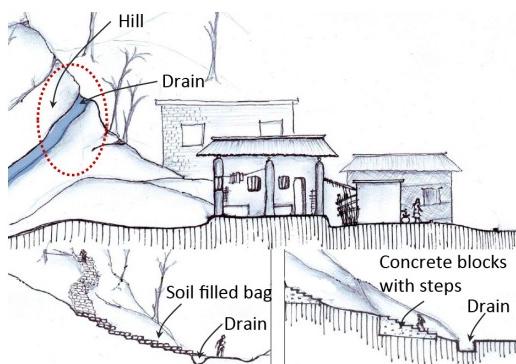


Corner bracing keeping the structure from bending under lateral loads due to earthquakes or strong winds (Sylhet). © A. Caïmi

D. EROSION (LANDSLIDES, RIVERBANK AND/OR COASTAL EROSION)

[ALL BANGLADESH]

- Bamboo grids are often built on river banks exposed to erosion. They work as wave breakers during floods when river currents become very strong. Placed diagonally to the river, they break the water flow preventing soil erosion and embankment failure. Their height is adapted to usual flood level. Bamboo grids are made with locally available and inexpensive materials (such as bamboos and coconut fibre ropes) allowing for easy and low-cost maintenance.
- Vetiver grass rows are planted on riverbanks or steep and unstable slopes vulnerable to erosion. Vetiver grass grows over extremely deep and massive root systems, capable of reaching 2 to 3m on its first year, which bind the soil providing a good anchor for backfill and topsoil. Vetiver grass has a good tolerance for extreme climatic and environmental variations, including prolonged drought, flooding and submergence.
- The planting of trees and shrubs is helpful to fight against erosion and harmful landslide effects.
- Surface drainage systems are common. They are executed with simple means and contribute to the mitigation of landslide effects.



Adaptation to landslide through drainage system in Swandip Colony, Chittagong. © Anirban M



Bamboo grids built on river banks exposed to erosion, working as wave breaker and helping control earth erosion during floods (Mymensingh). © A. Caimi



Vetiver grass rows planted on riverbanks to stop erosion thanks to its deep and strong roots (Mymensingh). © A. Caimi

5.2. PREVAILING DANGEROUS CONSTRUCTION PRACTICES

- During storms and cyclones, a great number of injuries are caused by flying CGI sheets. Fixing CGI roofing to bamboo structures is a problematic issue as conventional roofing nails were developed to connect CGI to timber purlins and are not effective when used with bamboo, which shrinks laterally as it dries.
- Construction in risky areas: in this division, specially on slopes with risk of landslide, coastal zones and river banks.
- Houses on stilts must be correctly braced and have deep enough foundations to avoid collapse.
- Flood protection know-how is rather limited in the urban slums of Dhaka. This is true with regard to the materials used for building (tin, bamboo, plastic), which do not offer much protection against flood waters, but also concerns collective technical infrastructures and structural protection devices against floods. Individual protection measures like raised plinths or elevated doors are very rare.
- Components to produce good quality concrete are not easily available. Non-saline water free from organic materials can be difficult to source. Aggregates (gravel) are very scarce in Bangladesh and often burnt brick chips are used, which affects the structural performance of the material.
- Knowledge and skills to produce good concrete as well as the necessary tools (e.g. for compacting) are rather limited, especially in rural contexts.
- Airborne salinity in coastal areas is aggressive to concrete and to steel reinforcement components and CGI sheets, accelerating their corrosion.
- Unethical building practices using illegal timber or sand are common and often exacerbated in post-disaster situations.



Stability problems in slum houses in Dhaka, Bangladesh, raised above ground level to protect against flooding. © Manoocher Deghati/IRIN

5. LEARNING FROM LOCAL HABITAT

5.3. LIFESPAN AND MAINTENANCE



[ALL BANGLADESH]

- The structural frame of houses built on stilts is often supported by short separated posts driven into the ground. The posts anchor the building to the ground while keeping the main structure elevated and so protected from soil moisture. When damaged, these posts can be easily replaced without affecting the superstructure.
- A gap of about 5 to 15 cm is left between the ground and the lower part of the wall panels (CGI or bamboo). This disconnection prevents rising damp from the soil, increasing the lifespan of the panels. The gap can be closed with burnt bricks or other damp-proof materials in order to keep animals out and provide an additional support for the wall frame.
- Wooden or bamboo posts often stand on waterproof elements (e.g. stones or *katla/kaatla/shiri*, which is a local method for protecting the base of bamboo/timber posts by placing them on top of concrete stumps embedded into the plinth or ground and connecting them with MS -mild steel- clamps). This increases the durability of the structure by preventing posts from rotting. This technique is used for both stilt and on-the-ground houses. In cyclone prone areas, this protection is used mainly for the intermediary posts while the corner posts are driven directly into the ground or provided with a foundation to ensure sufficient stability and anchorage of the building.
- Treatment of bamboo by immersion in water is very common throughout the country, with better results when salt water is available. This treatment is mostly done with freshwater which helps washing the bamboo of its sugars (that attract termites). In coastal areas, seawater is used, which provides extra protection compared to a freshwater treatment (salt attacks termites by “pumping” their moisture as they have a very thin skin).
- The subdivision of walls into panels makes their maintenance easier. In case of damage, affected panels can be replaced and the need to rebuild the whole frontage is thus avoided, reducing maintenance and repair costs.
- The lower parts of the walls are sometimes built with earth (cob), burnt bricks or cement blocks, and the upper parts with reed mats, bamboo mats or iron panels. The lower portion of the wall is easy to maintain or more resistant to water erosion. Total cost is reduced as the upper portions can be built with cheaper materials.



Elevated structure to prevent from soil moisture permeation (Barishal).
© O. Moles



Short separated posts driven into the ground, easily replaceable (Barishal).
© O. Moles



Concrete plots (*katla*) to keep moisture from rising into the wooden structure and gap between walls and soil in Kuakata (Barishal). © O. Moles



Gap between soil and bamboo wall (Mymensingh).
© A. Caimi



Wooden posts often rely on one or more implanted waterproof elements (Bandarban, Chittagong). © o. Moles



Easy to replace jute stick panels (Rangpur).
© A. Caimi



Zinc wall protection (Mymensingh).
© O. Moles

[KHULNA]

- In Khulna district, panels of woven leaves (*gool pata* in Bengali) with a bamboo structure are placed at about 40 to 60 cm from the wall on the sides of the building that are more exposed to rain water and prevailing winds. The panels protect the earthen walls from erosion and degradation due to direct exposure to rain and strong winds. Maintenance cost and work are thus reduced as the lifespan of the wall is increased and the panels can be easily replaced using freely available materials. The gap between the wall and the panels prevents rainwater from affecting the earthen wall and allow for an air flow thus avoiding moisture.



Wall protection according to orientation in Ashashuni, Khulna. © O. Moles

[RANGPUR]

- In Dinajpur, when iron sheets are used as wall panels, a small piece of plastic recycled from used bottles or other items is sometimes placed between the head of the nail and the iron sheet. The plastic piece works as anti-rip reinforcement protecting the iron sheet from damage in strong wind situations, and so reducing the risk of wrenching of the sheets.

[SYLHET]

- In Sylhet, the earth platform on which the house is built is commonly reinforced through the addition of stones to prevent excessive erosion, which is also useful to prevent erosion due to water flowing from the roof.

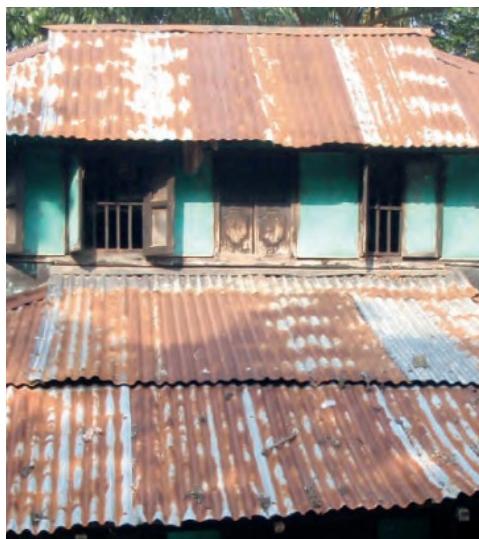


[ALL BANGLADESH]

- Thatch is a local material that can provide good insulation, ventilation and protection from rains, and can be a very viable technique to promote local skills when available. Nevertheless, thatch may become a nesting spot for insects and thatch roofs require frequent maintenance.
- Earth plaster requires regular maintenance, more specifically when roof overhang is limited.
- Mainly in coastal areas, CGI sheet roofing may corrode rapidly.

[SYLHET]

- In Sylhet, the dampness in plinths is a problem.



Corroded CGI roofing in coastal area (Kalapata)
©IFRC-SRU



Plinth protection with stones, also used to prevent erosion due to water falling from the roof (Sylhet). ©O. Moles



Plastic bottle pieces as washers between the nails and the CGI sheets to avoid the deterioration of iron sheets by the nails during strong vibrations under wind pressure (Dinajpur). © A. Caimi



Easily replaceable plywood panels (Barishal).
© O. Moles

5. LEARNING FROM LOCAL HABITAT

5.4. GREEN DESIGN AND COMFORT FEATURES



[ALL BANGLADESH]

- Iron sheets are sometimes used in the lower portions of walls as they are resistant to moisture. Since it is an expensive material and in order to avoid indoor overheating, it is used only for the panels closer to the ground.
- Different textures and porosity are sometimes found in wall panels: less porosity around the middle portion to ensure privacy, and more porosity on the upper portion of the wall, providing indoor ventilation.
- Open courtyards are desirable in the warm humid climate of Bangladesh, and houses are placed in such a way that there is always sufficient space for air to flow through.
- The south is an orientation very commonly chosen by families, because it is from this direction that the soothing cool breeze of the summer comes. The east is a possible second option after the south (probably in connexion with the Vastu Shastra Hindu architectural tradition). Since the cold winds flow from the north during the winter, openings to the north are usually avoided or closable. West orientation is not viable as prolonged exposure to the sun would heat up the building. The best option would be in theory a long row of houses facing the south, but usually houses are four-sided and therefore face all cardinal directions.
- CGI sheet roofs are sometimes covered with thatch to improve the thermal behaviour of the roof. Thatch may even function as a sound damper.
- The porous bamboo mat screens allow adequate cross ventilation for the interior of the building, a necessity in a hot and humid country.
- Thatch is a good material for roofing, as it allows great insulation, good ventilation and can provide protection from rain, as it expands when in contact with water. Also, it is a traditional craft - whereas CGI sheeting is imported and expensive to replace when needed. Nonetheless, CGI sheeting is valuable and can become useful when families need to raise funds as they can be sold (e.g. in a time of crisis).

[KHULNA]

- In Khulna, the vegetal double-skin system is used for improving comfort conditions indoors. The shade provided by the panels and the gap between the panels and the wall cool down the earthen wall and contribute to maintain a comfortable temperature inside the house. The panels are also used to protect covered exterior spaces (such as verandahs) from water during rainy seasons.



Wall protection according to orientation in Assasuni, Khulna. © O. Moles



Wall with three parts: iron sheets in the bottom part (more resistant to moisture); thick bamboo panels to ensure privacy in the middle portion and thin ones in the upper part to allow ventilation (Rangpur). © A. Caimi



Lower parts of the walls are built with earth (cob), burnt bricks or cement blocks, and upper parts with reed mats, bamboo mats or iron panels (Sylhet). ©O. Moles



- The use of CGI sheets causes a severe discomfort and may induce health issues, especially in a hot-humid climate. When a shiny CGI sheet is installed, it reflects part of the solar radiation, but allows the majority of it to pass through. The interior of the house and the roof itself quickly become very hot. When CGI sheets rust, they become darker in color and consequently reflect even less than the shiny sheets. Thus, building interiors become hotter as CGI sheets rust.
- In addition to the thermal disadvantage, CGI sheet roofs are noisy during rainy periods. False ceilings reduce the noise and create thermal buffer zones.
- Plinths and floors may suffer from rising humidity. Red Crescent medical advisers have raised concern about the risk of sleeping on cold, possibly damp clay floors and assumed this may be the cause of various rheumatic disorders. Raised beds/ indoor platforms are a solution. Is it also possible to apply a damp-proof-membrane over the mound which would stop capillary action.
- Thatch may be eaten out by termites, and it may provide a nesting ground for various types of harmful insects and serve as a daytime hiding space for mosquitos.
- Covered walkways are not built by dwellers between the different structures of the compound, which can prove uncomfortable in a country hit by heavy rains.

5.5. SOCIOCULTURAL PRACTICES FOSTERING RESILIENCE

- Individual preventive measures (e.g. saving money, storing food or medicine, organising building materials in advance) are common.
- Immediately after a disaster, affected households depend on bonding networks (relationships with immediate family members and relatives) and bridging networks (relationships with neighbours and friends) to cope with crises. Neighbours and relatives can play an important role during times of crisis. They are providers of food, clothes, and money. Moreover, they often are a source of emotional support, which is very important in difficult times.
- A common strategy implemented by affected populations is to move to safer areas and find temporary shelter either in relatives' homes, in another locality or on elevated terrains. This solution has its limitations, as for instance households in hazard-prone unions did not want to lose their assets like cattle, poultry, fishing gears, precious household belongings, etc., during catastrophes, and hence were not interested in moving to cyclone centres.
- Usually, even the poorest households can be sure to receive help by neighbours and relatives—and they also know that they will be obliged to help others in return.
- One of the most common coping strategies is to get a loan to buy food. Usually, people are able to borrow money from neighbours or relatives. Despite the difficult circumstances, average repayment times for loans are short, which indicates that borrowing does not necessarily lead to a vicious circle of indebtedness.
- Under normal flood conditions simple strategies like blocking the entry of the house with sandbags, positioning one's personal belongings on stilts of bricks or hanging them under the roof are sufficient to prevent any severe flood damage. In case of extreme floods, these strategies are not adequate and further adaptation and coping strategies are required.
- Many landlords offer food, lend money or repair damaged houses (e.g. in Dhaka).
- New varieties of (hybrid) crop cultivations in zones where salinity is rising.
- Some schools are used as temporary cyclone and flood centres.
- Before heavy rains and floods, families store seeds and crops in dry places.
- Before heavy rains and floods, a common strategy is to protect livestock animals.
- Before cyclones and nor'easters housing structures are usually reinforced (tied to posts or trees, doubling of structural elements...).
- People living in areas affected by coastal erosion, cyclones and floods need sometimes to move their home. E.g.: in Kutubdia Island (Chittagong), some families had to relocate their living quarters multiple times. Moving or relocating an individual household and accessing new lands are no easy task. Acquiring land on Kutubdia Island is difficult. Many were not able to buy land plots as they lacked means and thus relocated to government lands.
- Where possible, inhabitants move to higher areas during flood periods (e.g. Matlab municipality's inhabitants in Chittagong).



6. EXAMPLES OF PROJECTS BASED ON LOCAL BUILDING CULTURES

HOUSE DESIGN FOR BARISHAL

Project by: Caritas Bangladesh, BUET, CRAterre

General Information:

Location:

- District: Patuakhali
- Upazila: Kuakata
- Union: Dhulaswar
- Mouza/Village: Chargangamoti

Climatic profile: Saline area

- Avg. Max. Temp.: 34°C
- Avg. Min. temperature: 12.1°C
- Annual Rainfall: 2506 mm
- Avg. Relative Humidity: 81%



Site topography. © CRAterre

Design Considerations:

Available building materials: earth, bamboo, timber, sand, brick, MS rod, CGI sheet, etc.

Cost: BDT. 75,500

- Foundation: Wooden/ Bamboo posts embedded in soil (1-2 ft)
- Plinth: Earth
- Post: RC pillar and bamboo post
- Fence/Wall: Bamboo mat (2 parts)
- Openings: 1 main door + 1 inside door to connect rooms
- Ceiling: Ceiling is considered to protect heat and cold
- Roof Type: Four pitched & verandah (verandah roof is disconnected from main roof)
- Roof structure: Wooden truss
- Bracings: Corner bracing
- Treatment (bamboo & wood): Water treatment and partial chemical treatment
- Roof cover: CGI sheets



Completed house. © CRAterre

HOUSE DESIGN FOR CHITTAGONG

Project by: Caritas Bangladesh, BUET, CRAterre

General Information:

Location:

- District: Bandarban
- Upazila: Bandarban Sadar
- Union: Sadar
- Mouza/Village: Lemujhiri para

Climatic profile: Dry and cold

- Avg. Max. Temp.: 35°C
- Avg. Min. temperature: 13°C
- Annual Rainfall: 3031 mm
- Avg. Relative Humidity: 76%



Site topography. © CRAterre

Design Considerations:

Available building materials: earth, bamboo, brick, GI wire, CGI sheets, straw, wood, etc.

Cost: BDT. 80,000

- Foundation: Wooden/ bamboo posts embedded in soil (1-2 ft)
- Plinth: Earth
- Post: Wooden pole with concrete base (*katla*)
- Fence/Wall: Bamboo mat (2 parts)
- Openings: 1 main door + 1 inside door to connect rooms
- Ceiling: Ceiling is considered to protect heat and cold
- Roof Type: Four pitched and verandah roof disconnected from main roof
- Roof structure: Wooden truss
- Bracings: Corner bracing. Wooden tie beams in odd number
- Joints: Nails, notches, GI wire, plastic ropes
- Treatment (bamboo & wood): Water & partial chemical treatments
- Roof cover: CGI sheets



Completed house. © CRAterre

HOUSE DESIGN FOR DHAKA

Project by: Caritas Bangladesh, BUET, CRAterre

General Information:

Location:

- District: Munshiganj
- Upazila: Sirajdikhan
- Union: Lotabdi
- Mouza/ Village: Kangshapura

Climatic profile: Dry and cold

- Avg. Max. Temp.: 40°C
- Avg. Min. temperature: 11.5°C
- Annual Rainfall: 2121 mm
- Avg. Relative Humidity: 66%



Geotechnical Features:

- Topography: Low land, Flood prone area
- MSL: 5 m
- Soil Characteristics: Silt

Disasters:

- Flood and nor'easter (strong winds).

HOUSE DESIGN FOR KHULNA

Project by: Caritas Bangladesh, BUET, CRAterre

General Information:

Location:

- District: Satkhira
- Upazila: Shymnagar
- Union: Munshiganj
- Mouza/Village: Mothurapur(Jelepara)

Climatic profile: Saline area

- Avg. Max. Temp.: 35.5°C
- Avg. Min. temperature: 12.5°C
- Annual Rainfall: 1710 mm
- Avg. Relative Humidity: 76%



Geotechnical Feature:

- Topography: Plain land near river bank
- MSL: 3 m
- Soil Characteristics: Silt

Disasters:

- Tidal surge, cyclone and tidal surge, river flood, strong wind.

Design Considerations:

Available building materials: earth, bamboo, RC post, GI wire, CGI sheets, straw, wood, etc.

Cost: BDT. 63,000

- Foundation: Wooden/ Bamboo posts embedded in soil (1-2 ft)
- Plinth: Earth
- Post: RC pillar and bamboo post
- Fence/Wall: Bamboo mat (2 parts)
- Openings: 1 main door + 1 inside door to connect rooms
- Ceiling: Ceiling is considered to protect heat and cold
- Roof Type: Four pitched & verandah roof is disconnected from main roof
- Roof structure: Wooden truss
- Bracings: Corner bracing. Wooden tie beams in odd number
- Joints: Nails, notches, GI wire, plastic ropes
- Treatment (bamboo & wood): Water & partial chemical treatments
- Roof cover: CGI sheets



Completed house. © CRAterre

Design Considerations:

Available building materials: earth, bamboo, RC post, CGI sheets, tiles, *golpata*, wood, etc.

Cost: BDT. 85,000

- Foundation: Bamboo posts/concrete base (*katla*) embedded in soil (1-2 ft)
- Plinth: Earth (two/three steps)
- Post: RC posts at the corners of outer periphery + Treated bamboo on *katla*.
- Fence/Wall: *Tati* (bamboo sticks with earth plaster)
- Openings: 1 main door & open verandah at three sides
- Joints: Nails, notches, GI wire
- Ceiling: Ceiling is considered to protect heat and cold
- Roof Type: Four pitched & verandah (verandah roof is disconnected from main roof)
- Roof structure: Wooden/ bamboo truss
- Bracings: Corner bracing
- Treatment (bamboo & wood): Water treatment and partial chemical treatment
- Roof cover: *Golpata*



Completed house. © CRAterre

6. EXAMPLES OF PROJECTS BASED ON LOCAL BUILDING CULTURES

HOUSE DESIGN FOR MYMENSINGH

Project by: Caritas Bangladesh, BUET, CRAterre

General Information:

Location:

- District: Mymensingh
- Upazila: Dhubaura
- Union: Ghosegaun
- Mouza/ Village: Rajpur

Climatic profile: Dry and cold

- Avg. Max. Temp.: 33.5°C
- Avg. Min. temperature: 12°C
- Annual Rainfall: 2174 mm
- Avg. Relative Humidity: 80%



Site topography. © CRAterre

Design Considerations:

Available building materials: earth, bamboo, RC post, CGI sheets, straw, wood, etc.

Cost: BDT. 85,000

- Foundation: Bamboo posts in concrete base (*katla*) embedded in soil (1-2 ft)
- Plinth: Earth (two/three steps)
- Post: RC and bamboo posts with *katla*/without *katla*
- Fence/Wall: CGI sheet and bamboo mat (2 parts)
- Openings: 1 main door
- Ceiling: Ceiling is considered to protect heat and cold
- Roof Type: Four pitched & verandah (verandah roof is disconnected from main roof)
- Roof structure: Wooden/ bamboo truss
- Bracings: Corner bracing
- Joints: Nails, notches, GI wire
- Treatment (bamboo & wood): Water & partial chemical treatments
- Roof cover: CGI sheets



Completed house. © CRAterre

HOUSE DESIGN FOR RAJSHAHI

Project by: Caritas Bangladesh, BUET, CRAterre

General Information:

Location:

- District: Naogaon
- Upazila: Porsha
- Union: Chawer
- Mouza/ Village: Hiradanga and Uchadanga

Climatic profile: Dry and cold

- Avg. Max. Temp.: 45°C
- Avg. Min. temperature: 7°C
- Annual Rainfall: 1862 mm
- Avg. Relative Humidity: 74%



Site topography. © CRAterre

Design Considerations:

Available building materials: earth, bamboo, timber, binna grass, etc.

Cost: BDT. 90,000

- Foundation: Earth
- Plinth: Earth (two/three steps)
- Post: RC and bamboo posts with *katla*/without *katla*
- Fence/Wall: Earth
- Openings: 1 main door + 1 inside door to connect rooms
- Ceiling: Ceiling is considered to protect heat and cold & as storage + rain water harvesting system
- Roof Type: Four pitched and verandah roof disconnected from main roof
- Roof structure: Wooden truss
- Bracings: Corner bracing.
- Joints: Nails, notches, GI wire
- Roof cover: CGI sheets



Completed house. © CRAterre



Examples that illustrate the **reinterpretation and valorisation of traditional architectural features** in low-cost housing to reduce their vulnerability to local hazards

SCHOOL IN RANGPUR

School in Rudrapur. Project by: Anna Heringer & Eike Roswag

General Information:

Location:

- District: Dinajpur
- Upazila: Biral
- Mouza/ Village: Rudrapur

Climatic profile: Dry and cold

- Avg. Max. Temp.: 33°C
- Avg. Min. temperature: 14°C
- Annual Rainfall: 3334 mm
- Avg. Relative Humidity: 76%

Construction:

- Dipshikha / METI (Modern Education and Training Institute) with local labourers and own training workshop
- Footprint Area: 275 sqm
- Project Year: 2007

Disasters: drought, strong winds, earthquake.



Anna Heringer's handmade school in Rudrapur. © Kurt Hoerbst

Design Considerations:

Foundation: 50cm deep brick masonry foundation rendered with a facing cement plaster. Aside from the foundation, the damp proof course (double layer of locally available PE-film) was a fundamental addition to local earthen building skills.

Cob walls: The ground floor is realised as load-bearing walls using a technique similar to cob. A straw-earth mixture with a low straw content was manufactured with the addition of cow and water buffalo dung and then heaped on top of the foundation wall to a height of 65cm per layer.

Lintels and jambs: Lintels and jambs were integrated as well as a ring beam made of thick bamboo canes as a wall plate for the ceiling.

Ceiling: (ground floor) triple layer of bamboo canes with the central layer arranged perpendicular to the layers above and beneath to provide lateral stabilisation and a connection between the supporting beams. A layer of planking made of split bamboo canes was laid on the central layer and filled with the earthen mixture.

Bamboo structure and walls: (upper storey) frame construction of four-layer bamboo beams and vertical and diagonal members arranged at right angles to the building. The end of the frames at the short ends of the building and the stair serve to stiffen it. These are connected via structural members with upper and lower sides of the main beams and equipped with wind bracing on the upper surface of the frame.

Roofing: A series of bamboo rafters at half the interval of the frame construction beneath provide support for the corrugated iron roof construction and are covered with timber panelling and adjusted in height to provide sufficient run-off.



View of the interior space in the upper floor. © Kurt Hoerbst

HOUSE DESIGN FOR SYLHET

Project by: Caritas Bangladesh, BUET, CRAterre

General Information:

Location:

- District: Sylhet
- Upazila: Kanaighat
- Union: Lauxmiprasad
- Mouza/Village: Monipur

Climatic profile: Saline area

- Avg. Max. Temp.: 33°C
- Avg. Min. temperature: 14°C
- Annual Rainfall: 3334 mm
- Avg. Relative Humidity: 73%

Geotechnical Feature:

- Topography: Plain land
- MSL: 11 m
- Soil Characteristics: Silt

Disasters:

- Flood, river bank erosion, nor'easter (strong wind), earthquake.



Site topography. © CRAterre

Design Considerations:

Available building materials: earth, bamboo, timber, etc.

Cost: BDT. 90,000

- Foundation: Bamboo posts/ *katla* embedded in soil (1-2 ft)
- Plinth: Earth (two/three steps)
- Post: RC and bamboo posts with *katla*/without *katla*.
- Fence/Wall: earth with *ikar*
- Openings: 1 main door + 1 inside door to connect rooms
- Joints: Nails, notches, GI wire
- Ceiling: Ceiling is considered to protect heat and cold.
- Roof Type: Four pitched & verandah (verandah roof is disconnected from main roof). Rain water harvesting system
- Roof structure: Wooden truss
- Bracings: Corner bracing
- Treatment (bamboo & wood): Water treatment and partial chemical treatment
- Roof cover: CGI sheets



Completed house. © CRAterre

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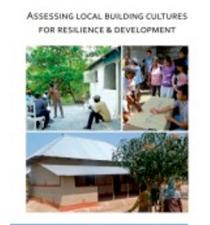


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KEY ISSUES FOR INITIAL DIAGNOSIS AND PROJECT IMPLEMENTATION

PROJECT MANAGEMENT

- Identify regulatory and social requirements.
- Identify and meet the different authorities.
- Involve representatives of the community (stakeholder groups) and local professionals as much as possible in the decision-making process for the project.
- Coordinate the project with other ones to develop yours in a comprehensive and integrated approach.
- Carry out a field survey as soon as possible to identify the strengths and weaknesses of local building practices and the local market, as well as actual capacities and training needs.



SOCIOCULTURAL PRACTICES FOSTERING RESILIENCE

- Analyse local practices regarding community cooperation in the building sector and other sectors (e.g. agricultural activities).
- Identify local practices regarding risk preparedness and recovery.



SITING

- Carefully select the construction site to avoid risky areas, comply with business activity area requirements and grant access to basic services.
- Plan for an easy access to drinking water and sanitation services.
- Take into account land tenure issues.



LOCAL HABITAT ASSESSMENT

- Identify local building practices and know-how and valorise the ones fostering the inhabitants' resilience. Appreciate and adapt to local practices, including in the informal sector.
- Identify local practices that contribute to an ecological and comfortable habitat.
- Identify weaknesses so as to give focus to the technical reflection (reverse-engineering process).
- Include building maintenance and repair related issues in the reflection.
- Collect feedback from previous projects.
- Consider different scales: materials, elements, construction systems, building, neighbourhood, environment, territory.



ARCHITECTURAL DESIGN AND CONDITIONS OF USE

- Make sure that the solutions and practices you promote are financially and technically accessible for most people so as to ensure the long term impact of the project.
- Identify the composition of the household and local practices in terms of cohabitation and uses of indoor and outdoor areas.
- Question the concepts of durability, dismantling and reuse related to local customs.
- Allow for a flexibility of the building system so that inhabitants can develop appropriation processes and make it evolve all along its lifespan according to their needs and abilities.
- Carefully define the orientation and position of buildings and public/private outdoor spaces into the compound, and the landscaping of the latter.
- Ensure that the building design provides a sense of pride among beneficiaries.



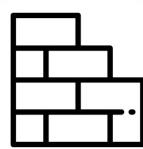
CONSTRUCTION AND BUILDING LIFESPAN

- Select materials according to their availability and accessibility and check their quality. Select materials in order to facilitate their reuse or recycling.
- Carefully design and build the crucial elements related to risk reduction: the anchorage of the roof and the walls to the foundations, the structure bracing devices, the water-resistant plinth and/or the post ends protection systems, the protection of walls (plastering, grouting), the seismic bands, etc.
- Sensitise people about the importance of regular maintenance in DRR.
- Assess material sourcing and reuse options to ensure environmental sustainability.



BUILDING PROCESS

- Develop and insist on the potential pedagogical value of the project and on the importance of its replicability.
- When possible, build a prototype that will allow to make any necessary adjustments.
- Beware of climate and seasonal constraints affecting the availability of people and materials.
- Analyse the social aspects of the building processes and their impacts on the community cohesion and the efficiency of works. Ensure that traditional mutual help systems are valorised.
- Give priority to local populations and artisans in the building process to ensure a positive impact for the community.
- Pay attention to supervision, training and communication needs.



		THE FIELD SURVEY										CAIMI (2015)	
		ASSESSMENT CONTENTS & MAIN INFORMATION SOURCES	COMMUNITY MEMBERS	INHABITANTS / TENANTS / HOUSE AND LAND OWNERS	SELF BUILDERS / CONSTRUCTION ARTISANS	MATERIALS PRODUCERS / SUPPLIERS / CONTRACTORS	TECHNICIANS / EXPERTS CONSTRUCTION SPECIALISTS	LOCAL AUTHORITIES / GOVERNMENTAL DEPARTMENTS	FORMAL & INFORMAL COMMUNITY LEADERS	GOS & INGOS / COORDINATION BODIES	VOCATIONAL / ACADEMIC / RESEARCH / TRAINING CENTRES	OBSERVATION IN THE FIELD	DOCUMENT REVIEW
ASSESSMENT CONTENTS & MAIN INFORMATION SOURCES		● main source ○ complementary source											
SITE			Community members	Inhabitants / tenants / house and land owners	Self-builders / construction artisans	Materials producers / suppliers / contractors	Technicians / experts construction specialists	Local authorities / governmental departments	Formal & informal community leaders	Gos & ingos / coordination bodies	Vocational / academic / research / training centres	Observation in the field	Document review
Natural environment	●							●	●			●	●
Socio-economic profile	●							●	●	○		●	●
Infrastructures	●							●	●	○		●	●
HABITAT													
Settlements	●			●	●	●		●	●	●		●	○
Housing/building typologies	●			●	●	○	○	○	●	○	●	●	○
Building construction	●			●	●	●	○	○	●	●	●	●	○
CONSTRUCTION PROCESS													
Activities & roles	●	●	●	●	●			●	●		○	○	
Maintenance	●		●	●	●								
Training		○	●	●	●	●	●		○	●	●		
RESOURCES													
Materials	●	●	●	●	●	○				●	○	○	
Skills & know-how	○	●	●	●	●	●	●		○	○	●	○	
Costs	●	●	●	●	●	●	○	○					
RISK REDUCTION													
Natural hazards & risks	●	●	●	●				●	●	○		○	○
Adaptation & coping strategies	●	●	●	●				●	●	○		●	
CAPACITIES													
Organizations & networks	●			○	○	○	○	●	●	○			
Cooperation systems	●	●	●	●	○	○	○	●	●	○			
Key persons & groups	●	●	●	●	●	●	●	●	●	●	●		

TO FIND OUT MORE



ON PROJECT MANAGEMENT AND FIELD SURVEYS:

- Assessing local building cultures, a practical guide for community-based assessment (Caïmi, 2015)
https://hal.archives-ouvertes.fr/hal-01493386/file/16059_Caimi_Assessing_local_building.pdf

SELF-ASSESSMENT SUSTAINABILITY TOOL FOCUSED ON SHELTER AND SETTLEMENT RECONSTRUCTION IN THE AFTERMATH OF NATURAL DISASTERS:

- QSAND Tool
<http://www.qsand.org/>

SUSTAINABLE HOUSING DESIGN TOOL TO ASSIST HOUSING PRACTITIONERS IN DESIGNING EXEMPLARY SOCIALLY AND CULTURALLY RESPONSIVE, CLIMATE-RESILIENT AND ECONOMICALLY SUSTAINABLE HOUSING PROJECTS:

- Sherpa Tool
<https://unhabitat.org/sherpa/>

ONLINE REFERENCE GUIDE WITH TOPICS (POLICY, PROGRAM AND OPERATIONAL FRAMEWORK) TO BE MANAGED IN EMERGENCY SITUATIONS:

- Care Emergency Toolkit
<https://www.careemergencytoolkit.org/>

ACKNOWLEDGEMENTS

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